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ARMY ORDNANCE

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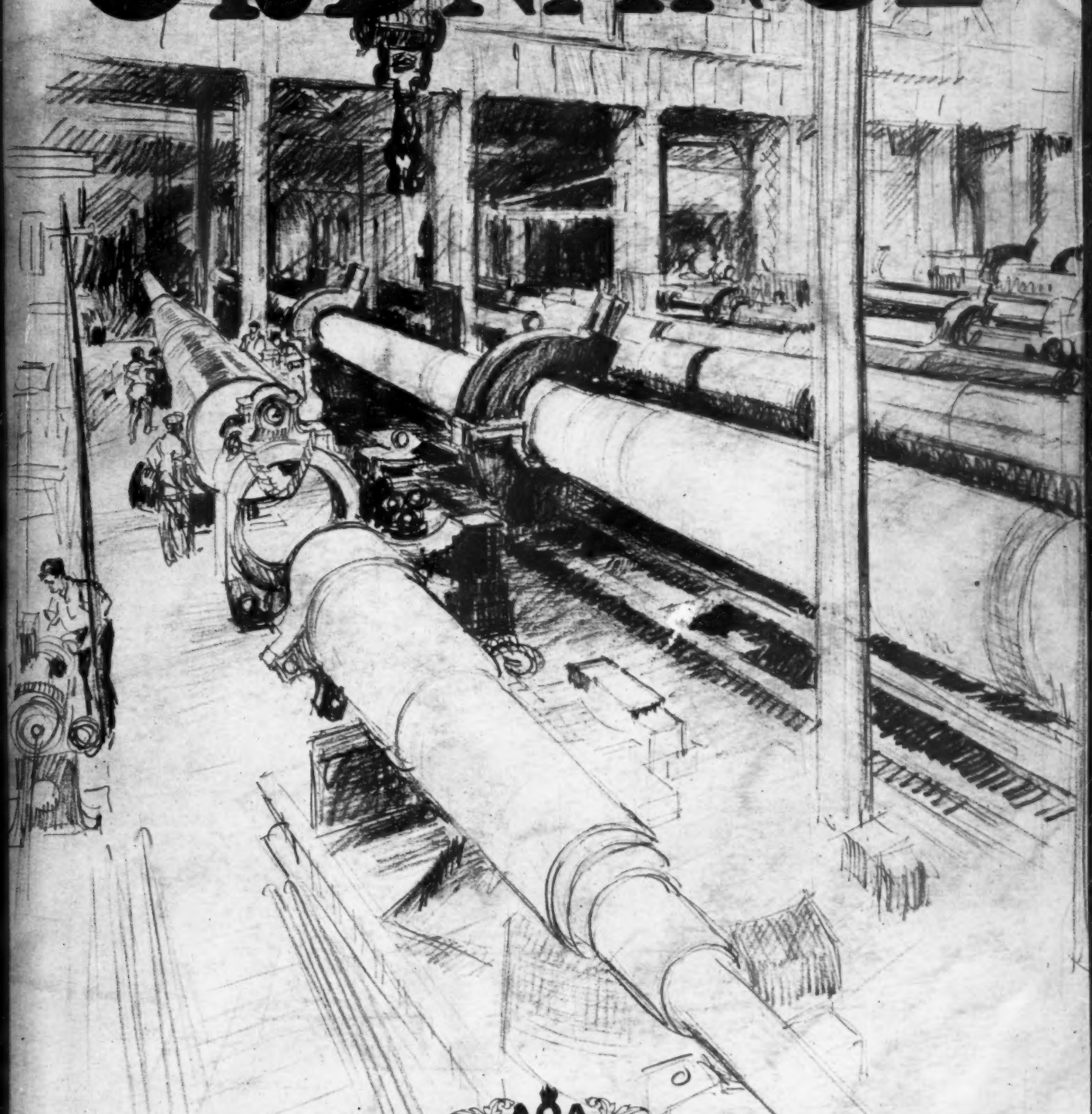

AOA

THE JOURNAL OF THE ARMY ORDNANCE ASSOCIATION

Vernon Hoxie Baker

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NEW YORK CHICAGO ST. LOUIS

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FOR
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ARMY ORDNANCE

The Journal of the Army Ordnance Association

Pledged to Public Service in Effecting Industrial Preparedness for War as Our Strongest Guarantee of Peace

Published by the Army Ordnance Association, The Mills Building, Washington, D. C. L. A. Codd, Editor.

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Pledged to Public Service in Effecting Industrial Preparedness for War as Our Strongest Guarantee of Peace

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THE Army Ordnance Association is a national organization of American citizens pledged to industrial preparedness for war as our Nation's strongest guarantee of peace.

THE Association endeavors to keep alive an interest in and knowledge of the design, production and maintenance of munitions. Other than a few manufacturing arsenals—six in all—there is no peace-time industry for the production of ordnance. Should war unhappily come again, industrial America will be called upon to produce munitions in great quantity and of intricate and unusual design. In an emergency time will not permit careful study or long preparation for the production of munitions. The problem is one of vital concern.

THE Army Ordnance Association believes that the solution of this problem, based on experience, lies in an active organization at all times coöperating with the Government. The principal objective of the Association is an active membership of American citizens, on whom the duty of design and production of munitions will fall in war, who will have an accurate and authentic knowledge of the complex requirements of ordnance. "Peace Insurance" in this form is the foremost aim of the Army Ordnance Association.

THE Association is purely patriotic; it has no commercial interests, no political alliances, and no religious affiliations. It is not operated for profit: its income is expended in furthering its aims. Its officers and directors serve without remuneration.

ARMY ORDNANCE, the journal of the Association, is published solely for the purpose of disseminating information on the progress of our munitions developments so that American industry may at all times know its responsibilities to the common defense.

The objectives of the Association as set forth in its Constitution are:

To assist in effecting industrial preparedness for war as being one of the Nation's strongest guarantees of peace;

To keep available the highly specialized knowledge necessary for arming the manhood of the Nation by stimulating interest in the design and production of ordnance material;

To promote mutual understanding and to effect cooperation with American Scientists, Inventors, Engineers and Manufacturers in civil life and the Regular and Reserve Officers of the Army Ordnance Department;

To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

To commemorate the services rendered by the Industry of the Nation and by the Officers and Civilian Employees of the Ordnance Department in the wars in which the United States has been engaged.

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Chosen May 21, 1930, to Succeed Maj. Gen. C. C. Williams, Ret., As Head of the Vast Industrial and Military Activities of the Ordnance Department, U. S. Army

ARMY ORDNANCE

VOL. XI JULY-AUGUST, 1930 No. 61

Fundamentals of Industrial Mobilization

The Simple and Practical Bases of Our Preparedness Plan

By Frederick H. Payne*

IN the brief period that has elapsed since I was appointed the Assistant Secretary of War and became legally responsible for making provisions for industrial mobilization in war, it has obviously been impossible for me to become familiar with all the problems involved in the performance of this task. Necessarily, I have devoted most of my attention to a study of the basic provisions of the plan begun in 1920 and whose development has continued steadily, if slowly, ever since. Broadly speaking, the plan concerns itself with the fundamental relationships that should exist in war between government and industry, and with the methods whereby military forces will secure necessary munitions from industrial establishments.

In attempting an analysis of these matters, I find that now I am approaching many of the same questions from the standpoint of a governmental official which formerly I studied almost solely from that of an industrial executive. Possibly for this reason I find that the problem of industrial mobilization holds for me a peculiar and natural interest.

By studiously avoiding the manifold and intricate details, I have succeeded sufficiently in absorbing the fundamental principles of the plan adopted by my predecessors to state that they have my entire approval, and will receive my hearty support as long as I retain the responsibilities devolving by law upon the Assistant Secretary of War.

In discussing the plan, first it is necessary to obtain a clear conception of the results we are trying to secure. In other words, what do we mean by industrial mobilization? Do we imply that in an emergency national industry should be marshaled into a military or semi-military organization, subject to the necessarily strict and direct discipline of armed forces in the field? Do we contemplate that presidents of corporations will be made colonels in the Army, or shop foremen, chief petty officers in the Navy? Do we insist that all industry should be compelled in war to operate under uniform production, sales and accounting systems laid down by the Federal Government in Washington? Most emphatically we do not.

Our purpose is simple—to see to it that every individual and every material thing shall contribute, in the manner demanded by inherent characteristics, their full share to the winning of any war in which we may become involved. Simplicity and practicability are the foundation stones of the plan through which it is proposed that this result shall be attained.

Before 1914 military men had but dimly perceived the tremendous influence that industrial and economic factors would exert in a modern war. Probably more striking than any other single lesson of the late war was that, when great nations resort to armed conflict today, the readiness of each to meet promptly the needs of its armed forces in munitions, and of its civilian population in the necessities of life, may well prove to be a decisive factor in the contest. Today a nation faced with a grave military emergency

Tenth Anniversary

THE first issue of ARMY ORDNANCE*—an unprecedented publication in a field not previously given to much public discussion—made its appearance in July, 1920. The present issue, the first of Volume XI, is an anniversary number in that it marks the beginning of the second decade in the life of this Journal.*

During the past ten years ARMY ORDNANCE *has endeavored to bring to the engineers, executives and manufacturers of American industry who comprise the membership of the Army Ordnance Association accurate and current chronicles of the development of munitions, the needs and functions of the defense services—particularly of the Ordnance Department of the Army—and of the progress of industrial preparedness. These general topics embrace policies and practices which demand the best thought of our industrialists, the best plans of our Army and the united effort of both. To assist in fusing such hitherto unrelated spheres into unity of outlook and action at least has been the aim of the publication; whether it has succeeded is for others to judge.*

ARMY ORDNANCE *is privileged to present to its readers as the leading article of this, its tenth anniversary number, a statement on industrial preparedness from the pen of Frederick H. Payne, recently appointed the Assistant Secretary of War. By reason of his tireless interest in ordnance affairs—at the time of his appointment he was assistant chief of the Bridgeport Ordnance District—and his career in business and industry, Colonel Payne brings to his new duties a background of knowledge and experience already bearing fruit as is shown in the analysis of his problem presented here. To him and his distinguished predecessors in that important office, to the officers of the Army, the captains and engineers of industry and the great rank and file who have assisted so splendidly in making* ARMY ORDNANCE *what it is sincere thanks are extended.*

In the beginning of its eleventh year ARMY ORDNANCE *renews its dedication of a decade ago, "pledged to industrial preparedness for war as the Nation's strongest guarantee of peace," and offers to those who are charged with the responsibilities of munitions development and planning its constant coöperation in all matters wherein industry and the national defense are mutually concerned.*

THE EDITOR.

*The Assistant Secretary of War.

must look as anxiously to her capacity to forge the weapons of war as she does to the ability of her Army and Navy to use them. Consequently, when the emergency comes, we cannot with impunity cripple any essential industry. If its ability to produce the articles upon which our armed forces depend is weakened by a lack of skilled labor, by a shortage of money, or because it is forced to operate under unaccustomed or inappropriate methods, then we are lessening our own chances of victory just as surely as though we deliberately should sink a fleet of our own troop-laden transports in the middle of the Atlantic.

THE paths of industrial currents are rather definitely fixed. The flow of trade involves: the movement of raw materials and of finished articles along accustomed routes; financial arrangements almost permanent in their periodical renewals; concentration of labor at strategic points; development of power systems to meet the needs of particular areas; and the gearing of industrial establishments to meet the requirements of a continuing demand. All these are interdependent—violent disturbance in any one of them entails a dislocation in the whole.

As a first principle then we must adjust the war load to our productive facilities in such a way as to occasion the minimum of disturbance in the ordinary industrial processes of the country. To accomplish this the Office of the Assistant Secretary of War as a first step has taken the great "shopping list" containing the estimated war-time requirements of the Army and, through representatives stationed in all parts of the country, has parcelled it out in accordance with the capacity of each part to absorb the additional load assigned to it. Furthermore, in order to occasion in an emergency the minimum of disturbance in production methods, the Army has substituted, as far as possible, items in commercial use for those articles of equipment whose manufacture demands alterations in shop layouts, methods, and so on. This, of course, cannot be done in the case of ammunition, guns, bayonets, fighting planes and similar essential items the employment of which is limited strictly to combat.

Through "gentlemen's agreements" made in peace with individual establishments we are able to insure the speediest possible initiation of a production program in war. It is true that these agreements have no binding force but they serve to show us what can be done, and forewarn the manufacturer of the job that will probably fall to his lot. No agreement is made by the Army with an industrial establishment particularly adapted to meet the needs of the Navy, and in no case is more than half of the normal capacity of a plant obligated. These measures will enable the manufacturer to supply, on a reduced basis, his civilian customers during a war, and will facilitate the return to normal peacetime business after the war is completed.

GRATIFYING progress has been made in working out the details of this munitions procurement program. We certainly will not be faced again with the necessity of rushing frantically to the commercial world with our war-time shopping list in an attempt, through the offer of exorbitant prices, to make good deficiencies in peace-time planning.

However, no matter how efficiently we distribute the munitions production task to industry, as quickly as plants begin work on the millions of articles needed, there will be created some shortages in secondary requirements, and disturbances in the whole industrial fabric of the Nation. If sea trade is not maintained shortages in certain critical raw materials will rapidly become acute. Rubber, tin, nickel, iodine, manganese, and some few others are either not produced in our country or are produced in insufficient quantities to meet the needs of the country in war.

Where possible, plans must provide for substituting plentiful raw materials for scarce ones—for conserving critical materials for essential uses—and for increasing sources of supply. Prices must not get out of hand. Experience has shown that when prices begin to rise in war they rush in dizzy spirals to heights that cannot fail to have the most demoralizing influence on the whole population. Mounting prices entail an unequal distribution of the war burden, and a sapping of morale among those whose efforts and hardships are apparently capitalized by others whose situation enables them to take advantage of the emergency conditions. Obviously a systematic and effective control of our industrial and economic resources will be necessary in a major war. Such control can come from the central Government alone. In no other place can there be found a knowledge of the Nation's requirements as a whole, nor can there be placed the requisite authority to insure compliance with the directives and orders that will necessarily be issued.

Consequently, in the event of war, a great industrial organization will certainly be a part of the Federal Government during the period of the emergency. This organization must be made up of leaders in all the branches of industry. Representatives of labor, of manufacturers, of financiers, of the professions, of agriculturists, of producers of raw materials and so on must combine in an organization under the President to guide our industrial effort along those lines that will insure speedy victory—and justice to every citizen.

THUS the existing plan for industrial mobilization is seen to be simple in conception. It provides for making peacetime arrangements to insure prompt initiation of munitions production in the event of war; for the determination of methods whereby men, money, and materials may be set to work in the interest of the whole Nation; and for setting up an industrial organization to administer and carry out the execution of the war-time industrial task. But the complete preparation of such a plan is a most intricate and difficult work. Studies to determine how the various desirable results may be attained—plans to make effective promptly the schemes adopted—constant experimentation with new materials—accumulation of gages, tools, jigs, and fixtures, and other equipment to install quickly in new or converted establishments—insuring the existence of the skilled labor required in non-commercial processes—all these and more must be carried on continuously.

Needless to say, without the hearty coöperation of patriotic civilians the task would be a hopeless one. But with this help, unselfishly given, progress is being made. Today we cannot say that we are ready to the last cartridge box—we never will be—but we have a clear understanding of the capacity of the Nation to make cartridge boxes. What is more we have the assurance that the Army, the Navy and industry can promptly undertake their respective tasks in an orderly and efficient way, if unhappily we must again take up arms in the defense of our Country and its institutions.

The Job Ahead of Us

The Magnitude of the Ordnance Problem and Its Needs

By James L. Walsh

DIRECT expenditures during the World War averaged about $1,700,000 per hour for the nineteen months beginning April 6, 1917. This direct expenditure, however, is but a part of the story. In fact, according to an estimate made by ex-President Coolidge in a speech delivered on Armistice Day 1928, the total money cost of the World War, including the interest on war debts until extinguished, will ultimately aggregate one hundred billion dollars.

In a sense, we were burning up and blowing up our accumulated capital at the rate of one million dollars worth every *eight minutes the war lasted*. Industrial preparedness, to effect which the Army Ordnance Association has pledged itself, consists essentially of doing all of those things which can be done and should be done previous to a great national emergency, with a view to lessening the possibility of aggression, hastening the time when the Nation can exert its full military strength, and compelling a victory in the shortest possible time—incidentally, with the least expense to the taxpayers.

JAMES L. WALSH
Chief, New York Ordnance District, President, New York Post, Army Ordnance Association.

Based upon the World War scale of expenditures, both direct and subsequent, every effort which would tend to lessen the duration of a similar conflict would save us the round sum of one billion dollars for every six days by which the period of hostilities was shortened. The Army Ordnance Association is one of the agencies, and perhaps the principal non-governmental agency, which seeks to anticipate, and therefore lighten, the great burden of mobilizing industry for national defense, which, from the nature of things, must devolve very largely upon civilian engineers, scientists and manufacturers in coöperation with the Ordnance Department of the Regular Army.

POSSIBLY it will be worth while to break down into its major elements this huge business enterprise of defending our sovereignty in the event war, unfortunately, should be again thrust upon us.

During the World War, Congress appropriated or authorized the expenditure of

A grand aggregate amounting to	$37,300,000,000
Of which the Army's portion was	32,758,000,000
And the Navy's share amounted to	4,542,000,000

Measured in dollars and cents, then, the Army's job was almost exactly eight times as great as the Navy's job. As a matter of fact, this same proportion holds approximately for the number of men recruited for the respective Services.

The huge total provided by Congress for all Army purposes consisted of

Cash appropriations	$24,236,000,000
Contract authorizations	8,522,000,000
A total of	32,758,000,000

For ordnance purposes, viz: providing the enormous quantities of rifles, machine guns, and artillery of all calibers; ammunition for small arms, machine guns and artillery; tanks, tractors and other miscellaneous implements of war, Congress provided

Cash appropriations	$7,801,000,000
Contract authorizations	8,046,000,000
A total providing fighting equipment for our first five million men, in the sum of	15,847,000,000

If we accept the amount of money involved as a common denominator for evaluating the relative importance of our major activities during the World War, it will be seen that the ordnance problem for the Army alone was almost exactly one-half of the whole Army program, and, what is more significant, the magnitude of the Army Ordnance problem was three and one-half times as great as the whole Navy problem in all its many ramifications.

The cost of equipping our first five million men with ordnance, viz.: sixteen billion dollars, is a most difficult sum to visualize on account of its magnitude. However, most of us have seen battleships at anchor in the Hudson River. Sixteen billion dollars would provide a column of first class battleships reaching from New York City to Albany at normal distances, swinging at anchor in quiet waters. If we had been successful in meeting our ordnance requirements for the first two years of the World War, it would have been equivalent, in terms of labor and raw material, to building every structure in all the Boroughs of New York City, once a year or, stated in terms of equivalent cost, would build a Panama Canal every fifteen days for a period of two years.

Based upon mere magnitude alone, the problem confronting the Ordnance Department, U. S. Army, and the

Army Ordnance Association is difficult enough to challenge the best brains, energy and courage we can mobilize for its solution. But the situation, unfortunately, is complicated by the inherent difficulty of having no parallel peace-time activity to stimulate knowledge of the design and manufacture of ordnance and thus furnish a quickly available auxiliary personnel for the expansion of the permanent Ordnance Department in emergency.

Another factor which complicates the solution of the ordnance problem is that weapons of war change rapidly and the industries of America must be prepared to furnish the latest and most effective types of weapons to the boys who are risking their lives in the trenches. Also, the agencies devoted to industrial preparedness must take into consideration greatly increased employment of the various types of weapons adopted as standard. At the start of the World War a total of fifty machine guns was the standard equipment of an infantry division. At the time of the Armistice, the tables of equipment called for an increase of 2060 per cent in this type of equipment. The tendency is in the direction of increasingly complicated mechanisms—which are correspondingly increasingly difficult to manufacture.

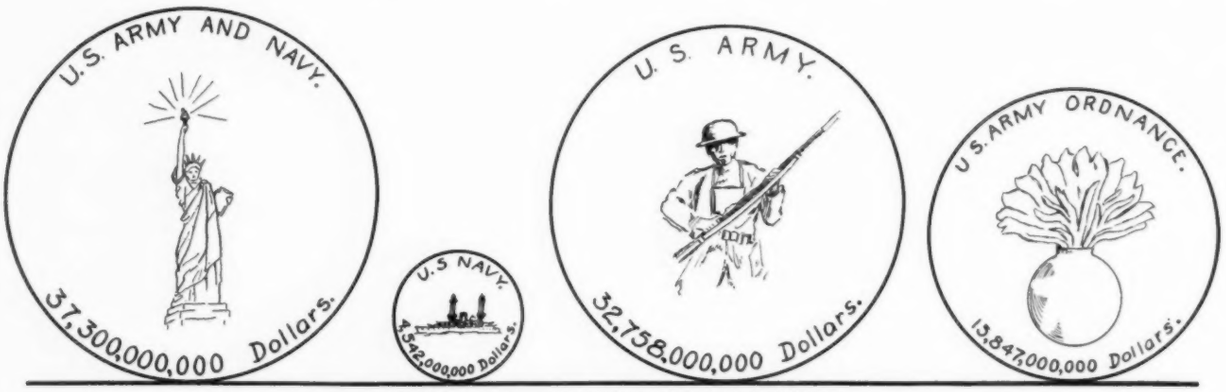
Reduced to its essentials, then, the ordnance problem requires for its solution a preponderant share of our industrial war effort; prompt production of huge quantities of material not produced commercially in times of peace; provision for quickly adapting the production program to necessary changes in design and quantity; and vitally important accuracy of fabrication.

LET us next consider what steps have been taken since the Armistice in preparation for meeting a future emergency of similar size. First, as to design—it may be said that improvements and refinements effected by the Ordnance Department, U. S. Army, since the Armistice render the latest developed types of each weapon at least equal to anything known to have been developed abroad. As to the determination of requirements—the tremendous job of computing the amounts of each of the twelve hundred major articles of ordnance needed to equip the combat forces, and the approximate time-schedules for desired deliveries—this has been performed with intelligence and accuracy.

The total Army requirements for ordnance have been broken down into district quotas, and manufacturers in each district have been designated for practically all of the more important items. Incidentally, this matching of Government requirements with existing facilities will probably save at least thirty days of the needlessly wasted time spent in surveying plants, negotiating contracts, etc., which characterized our recent improvised, and therefore extravagant, attempt to prepare the Nation to defend its sovereignty. On the World War basis of *ultimate* costs at the rate of seven million dollars an hour, it will be seen that this work alone would save the Government a clean five billions of dollars in the event of a similar emergency.

We have made some progress in connection with the next to the last phase, which, we hope and believe, will save an additional sixty days and a corresponding additional ten billion dollars in making the Nation ready to defend itself—this through the making up by individual manufacturers of what we call emergency production plans.

The fundamental principals of industrial preparedness are pretty generally understood; but the difficulties which lie in the way of applying those principals are not fully appreciated. Every thoughtful American agrees that industry should know in advance just what each factory should make in emergency, how many of each article and when each lot must be delivered to fit in with the general mobilization program. However, when all of that is accomplished, only a very small part of the job has been finished—when we are dealing with the Ordnance problem.



The Scale of American World War Expenditures.
With the dollar as a common denominator for relative importance, the Ordnance problem of the World War was almost one-half of the entire Army program and three and one-half times greater than that of the Navy.

ORDNANCE is essentially non-commercial. American industry today does not know how to manufacture ordnance. Industry has to be instructed in regard to its wartime duties—and there are all too few instructors available.

Now, there is only one way this handicap can be even partly overcome and that is to have more knowledge of ordnance manufacture available in the event of an emergency; and the only way to have more ordnance knowledge at the outbreak of war is to recruit and train more Ordnance officers in time of peace. It will be "too late" after the emergency is upon us. During the World War we made frantic efforts to increase the Ordnance Department from ninety-seven officers to eleven thousand—an increase of one hundred per cent per week for nineteen months—and it didn't work. True, there are Ordnance Reserve officers who are giving to the solution of this grave problem what time is available after the regular day's work is done, but this volunteer effort can never take the place of the continuously

applied energy of the full-time Regular Ordnance officer who is paid to do this work day in and day out.

We have met with nothing but the heartiest response from the manufacturers. However, soon after a willingness to proceed with emergency production plans is expressed, it becomes evident that a great mass of highly technical data regarding manufacturing operations must be applied to them. Only thoroughly trained Regular Ordnance officers can do this, and there is a growing demand that full-time officers be assigned to each individual plant to give continuous assistance in the preparation of the factory's emergency production plan.

THE Army Ordnance Association has rendered the Nation a great service in publishing ARMY ORDNANCE, and in popularizing the annual ordnance demonstration at the Aberdeen Proving Ground. We have succeeded in arousing the interest of the engineering professions and industry in general, but we have not yet succeeded in harnessing this intelligent and valuable interest and energy to the greatest practicable extent, and we will not be able to do so until we are ready to proceed to the final phase of industrial preparedness, namely the placing of "educational orders." Successfully to put into effect a program of placing educational orders, we need a vastly increased regular Ordnance Department. Time is required to convert blue prints into finished articles. The best factory plans in the world contain "bugs" which hold up production, and these "bugs" can be removed only by putting through the factory small experimental lots.

The remedy is, fortunately, a simple one, viz.: the placing by the Government of educational orders, not on a competitive basis as to price, but by giving due consideration to the knowledge acquired by the manufacturer which, after all, is what the Government is really after.

When all is said and done, our ordinary peace-time activities include fields of endeavor approximately parallel to war-time functions with two exceptions, viz.:

(a) The training of men in the *use* of arms, and
(b) The training of industrial plants in the *manufacture* of arms.

For training men in the *use* of arms, we have the Military Academy at West Point, the War College, Cavalry, Air Corps and other service schools, certain portions of the Regular Army not needed for insular garrisons or border patrol, the Reserve Officers' Training Corps units in our civilian colleges, the Citizens Military Training Camps and the National Rifle Matches. All of these are government institutions supported by federal and state appropriations.

All that the Government gets in return for substantial expenditures is the fact that a small number of its citizens have acquired a certain amount of proficiency, either individually or collectively, in the *use* of arms. It would seem to the lay mind equally logical that the Government should be willing to make reasonable appropriations to no other end than that certain of its industrial plants shall acquire the knowledge necessary to fabricate these arms and the ammunition for them—without which our men cannot become soldiers in the full sense of the word.

Stop and think what the infantryman would be without his rifle, ammunition and helmet—a living target for the enemy; or the artilleryman without his field gun and its shell and shrapnel—a helpless spectator to the slaughter of his infantry comrades. Consider the aviator, equipped with even the safest and swiftest airplane that money can buy—what could he do without his machine gun to fight off opposing planes, or his bombs to demolish fortified places? Without ordnance, even if he had the best airplane in the world, he would have nothing but a grandstand seat from which to witness the overwhelming defeat of our ground troops. We have heard a lot about airplanes sinking battleships. No airplane of itself, guided by even the bravest of our aviators, ever sank a single battleship; those that were sunk were sunk by ordnance.

Until we are ready to match our unrivalled manpower with an adequate and prompt supply of ordnance, it appears to the thoughtful layman that we have a weak link in our armor and all other preparations are not only futile but wasteful.

And, so it seems that the job ahead of us, as members of the Army Ordnance Association, is to endeavor to obtain (a) an increase in the Regular Army Ordnance Department to a sufficient extent to enable it to prepare for its huge wartime job; and, (b) authority for placing educational orders with civilian industrial plants in order to enable them to fit themselves for their wartime tasks.

Army Aircraft Above Low-Hanging Clouds Over San Francisco During Recent Air Corps Maneuvers.

Molybdenum in High-Speed Steel

The Elimination of Tungsten, A Strategic Material

By S. B. Ritchie*

IT would be difficult to form a correct estimate of the tremendous influence the introduction of high-speed cutting tools has had on the progress of civilization. When Robert Mushet, an Englishman, discovered air- or self-hardening steels in 1868, he started investigations which have continued for more than half a century and which have produced our modern high-speed steels. The important discovery of air-hardening steel came about more or less accidentally while Mushet was studying the effects of manganese, tungsten and other elements on iron with the object of improving ordinary carbon steel. From remote times ordinary steel had been hardened by quenching in water while at a red heat, but Mushet observed that one of the bars with which he was working and which contained both manganese and tungsten hardened by cooling in air without the usual heating and water quenching.

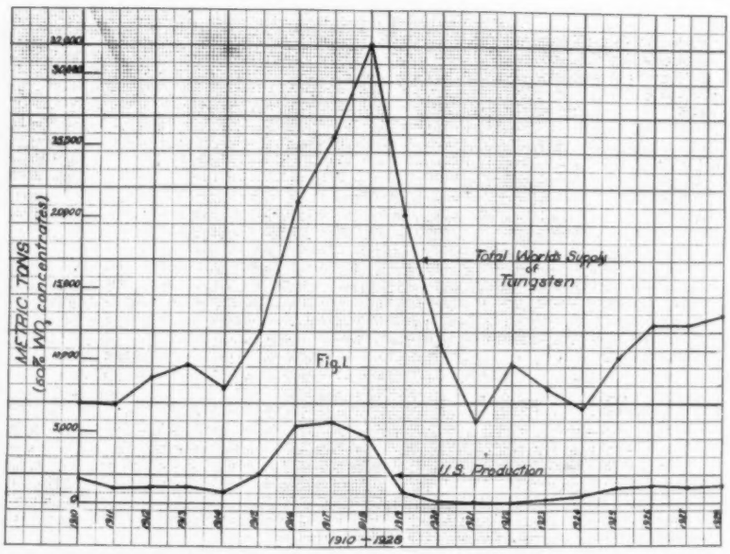


Fig. 1. Approximate Production in Metric Tons (2204.6-pounds) of Concentrates of Tungstic Acid in the United States and Total World Production, 1910-1928.

The introduction of Mushet steel was a distinct advance in the art of cutting metals. It was possible to work two or three times faster than with the old carbon tools and to handle work formerly too hard for carbon tools. The Mushet steels were used primarily to save frequent grindings or to permit doing jobs previously impossible and not for increasing speeds.

While it may be said that Mushet discovered the nature of tungsten steel, its wonderful possibilities, however, were not appreciated until about a quarter of a century after these steels had been in use in engineering. It was truly another milestone in the march of civilization when, about 1900, the industrial world awoke to witness a revolution in machine shop methods. This industrial revolution was brought about by the discovery that contrary to the general belief that tungsten steels were ruined by high heats they were so greatly improved that cutting speeds could be used which were truly astounding. Tools thus superheated were not ruined but on the contrary stood up better than those given the usual treatment, and apparently the higher the heat the better the tool up to the melting point. This remarkable discovery made by Taylor and White upset the traditions of centuries that steel must not be heated beyond a red, and inaugurated a feverish activity on the part of tool steel manufacturers which has continued to the present day.

It will be noted that tungsten has been the outstanding and predominant element in the establishment of high-speed cutting tools. It is also used for the filament in lamps, and as an alloying element in a number of ferrous alloys. Probably 90 per cent of the tungsten produced goes into high-speed steels. Its use has increased greatly in the past decade. Unfortunately there is not a great quantity of this metal native to the United States. The greater quantity of tungsten now comes from China, where labor costs are low and the huge deposits permit surface mining. Since 1910 China has pro-

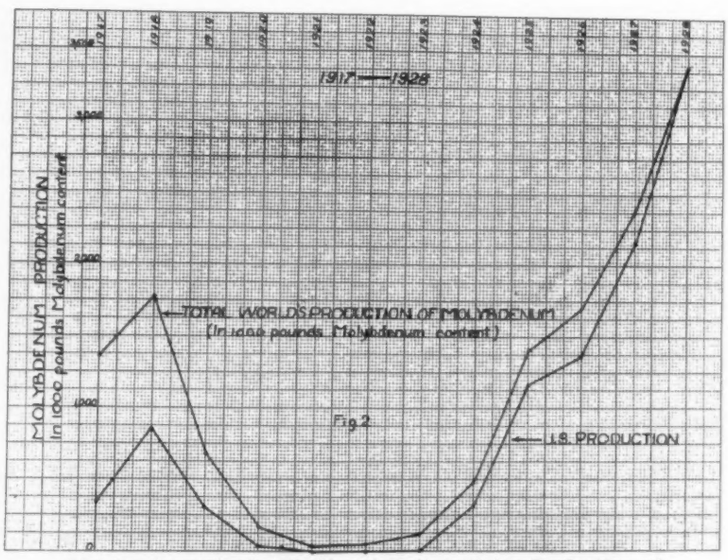


Fig. 2. Approximate World and United States Production of Molybdenum, 1917-1928.

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duced about 28 per cent of the total world supply. The development of the relatively small amounts of tungsten found in America has been influenced greatly by the tariff. Consumption of tungsten ores by the United States is normally about 4000 tons per year. During the World War it was from two to four times this amount. World consumption of tungsten ores has been calculated at not to exceed 15000 tons a year[1]. The graphs in Fig. 1 show in metric tons (2204.6 lbs.) of concentrates of 60 per cent tungstic acid, WO_3 (the commercial basis in this country): (a) the approximate production in the United States, and, (b) the total world production over the period 1910 to 1928[2]. The story of tungsten at the beginning of hostilities in 1914 is exceedingly interesting and the almost superhuman efforts exerted by some of the belligerent nations at that time to obtain supplies of the metal is most impressive.

During the World War the scarcity of tungsten in the Allied countries became very acute. Great efforts were made to find and develop new sources of supply of this valuable and apparently indispensable metal. The scarcity at that time showed conclusively that with emergency rate of consumption the known available quantities in this country, even if available for use when needed, are totally inadequate. In other words, were we ever completely cut off from outside supplies all our industries dependent on machine tools might be seriously handicapped and slowed down in the production of munitions of war and other essentials necessary and vital in a national emergency.

Fig. 3. Carbon-pile Crucible Furnace Used for Making Small Ingots.

A STRATEGIC raw material is by definition one that is not available in sufficient quantities in this country for war-time needs, and for which there is no adequate substitute. Tungsten therefore falls in this class, along with tin, platinum, antimony, and other metals.

Not only was there feverish activity during the war to increase the tungsten supply but efforts were made to find satisfactory substitutes. It has long been known that molybdenum possessed some of the qualities of tungsten, and during the war the intensive efforts made to locate additional sources of this metal established the fact that molybdenum exists in this country in ample quantity to take care of any national emergencies. During and since the war structural engineering steels containing molybdenum have assumed a prominent place and their use in the airplane, automotive and ordnance fields is increasing. One of the factors in retarding the development and extensive use of molybdenum until recently had been the fear of inadequate supply. Rapid strides in the knowledge and use of this metal have been made since the war. Fig 2 shows the approximate production of molybdenum from 1917 to 1928[3].

Since the World War it has been apparent that a satisfactory substitute for tungsten now used in high-speed steel was highly desirable. Under instructions of the Chief of Ordnance the Watertown Arsenal was directed to determine the practicability of eliminating tungsten wholly or in part from high-speed steels. Experiments were initiated about two years ago and in the studies that followed it was felt that molybdenum, due to its peculiar properties and to the abundant supply, offered most attractive possibilities. It was used in small quantities in some of the first high-speed steels ever made. It will be found today in relatively small quantities as an alloying element in a few brands of commercial high-speed steel.

MOLYBDENUM has, to a great extent, the special qualities possessed by tungsten which are so essential in a good high-speed metal cutting tool. Their physical properties are in fact quite similar in many respects. Both have high melting points, pure tungsten melting around 3300°C and molybdenum around 2500°C. Both belong to the chromium group, tungsten with an atomic weight of 184 and molybdenum, 96. It was this atomic weight that led to the assumption that approximately 1 per cent molybdenum should equal 2 per cent tungsten for replacement purposes. Red hardness is the quality of hardness at a red heat and both tungsten and molybdenum impart this quality to a certain extent under special conditions. A tool possessing red hardness will cut at such rate that the point of the tool will glow in a dark room and still maintain its hardness for many hours.

The program laid down at the beginning of this investigation called for the making and testing of a series of steels, the range of which ran the tungsten from 18 per cent to 0 and the molybdenum from 0 to 9 per cent in accordance with the following table:

W.	18.0	14.0	10.0	6.0	0	4.0	2.0	0
Mo.	0	2.0	4.0	6.0	9.0	0	1.0	2.0

It will be seen that 2 per cent tungsten is replaced by 1 per cent molybdenum. All tests were to be made in comparison with the standard 18 per cent tungsten steel. Only four compositions were made up and tested on this partial

1. Eng. Min. Jour.-Press. Aug. 8, 1925.
2. Data taken chiefly from "The Mineral Industry."
3. Data taken chiefly from "The Mineral Industry."

substitution program. The carbon ran from .68 to .74, and the molybdenum from approximately 2 to 7 per cent against tungsten 12.25 to 4.5 per cent respectively. The steel for these compositions was made from a small crucible furnace and poured into 4-inch square ingots weighing about 75-lbs. each. Fig. 3 shows the carbon-pile crucible furnace used for making small ingots.

A great deal of experimental heat treating was done on these preliminary tools and data assembled for use in complete substitution trials. It was disclosed by x-ray studies that good tools may be distinguished from inferior ones by the relative amount of carbide lines and by the relative expansion and distortion of the crystals as shown by the spectra. Good tools show large crystal expansion and relatively little free carbides. Further evidence that tungsten and molybdenum compounds are very similar is shown by the fact that steels containing no tungsten gave essentially the same spectrum lines as those containing no molybdenum. The presence of molybdenum seems to make the solution of carbides easier than is the case with tungsten.

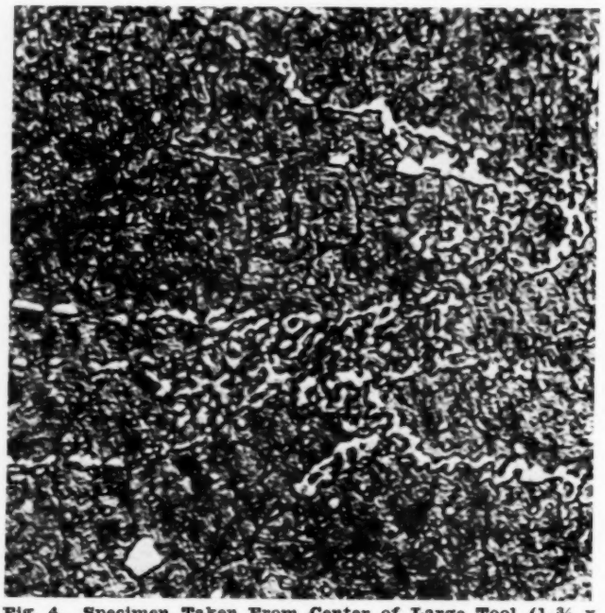


Fig. 4. Specimen Taken From Center of Large Tool (1-¾ x 2-½-inches). Made From 75-pound Ingot C..68, Mo. 9.39 Per-cent, Showing Dendritic Segregation and Traces of Eutectic Carbides. Insufficient Forging. X 1000.

In these preliminary heats proper forging methods had not been developed and a number of the tools were cracked either in forging or in hardening. It is probable the heat treatment used was not the best. Nevertheless, the performance of these tools was very gratifying and compared favorably with the regular tungsten tools. Apparently the cutting efficiency did not change materially as the molybdenum replaced the tungsten and the results obtained justified proceeding with complete substitution tests.

One of the first compositions made without any tungsten had the following analysis:

C.	Mn.	Si.	Cr.	V.	Mo.
.60	.22	.78	4.00	1.02	9.42

Small tools only were made from this heat but their performance was exceptionally good; as for example, a tool bit 1-inch square cut on a heat-treated nickel steel gun forging continuously for 16 hours before regrinding at speeds running from 25 to 40 feet per minute, feed .045 to .1-inch depth of cut 5/16-inch. While the performance of this composition was satisfactory it was deemed advisable to test compositions with variable carbons and variable molybdenums. Some twenty-three different heats were made up covering the range of carbon from .45 to .90 per cent and molybdenum from 7.5 to 11.5 per cent. As a result of the great number of service tests made it was felt that for general all-purpose work a combination of .68 C. with 9.5 Mo. was the best.

All the above heats except five were made using the 75-lb. ingot, 4-inch square cross section. Some of the large lathe and planer tools desired for comparative tests were 1¾ x 2½-inches. With the small ingot this gave a reduction of area in forging for the largest tools of less than 4 to 1 which

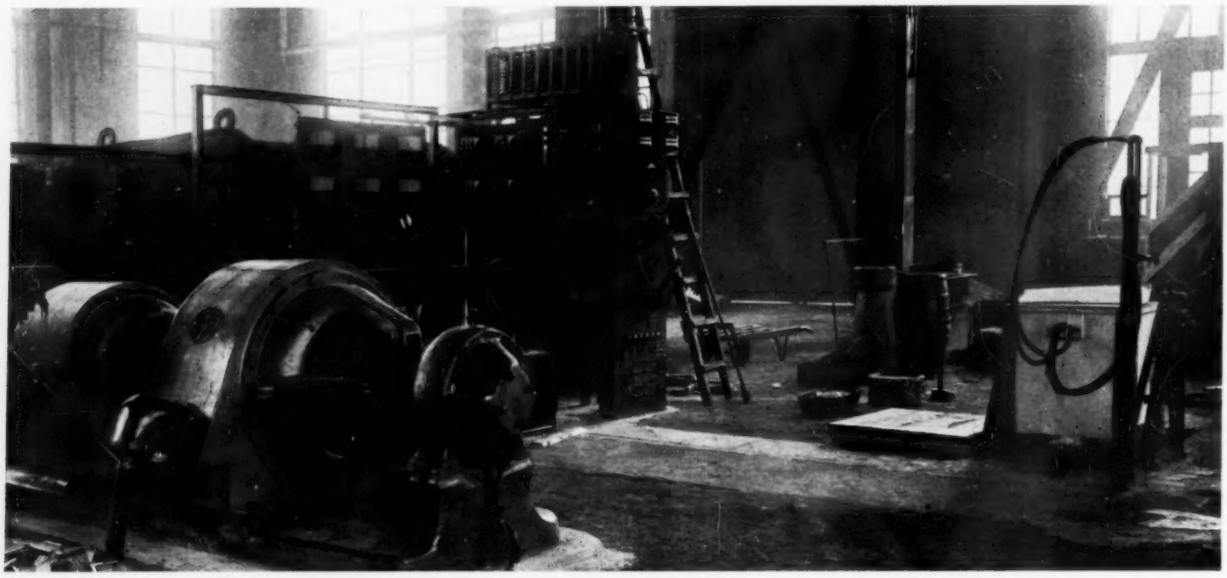


Fig. 5. 150 K. W. High Frequency Motor-Generator Set with 500-pound Furnace.

was found from micro-examination and from breakdown tests to be insufficient. Fig. 4, made from one of the large tools, indicates insufficient forging. Consequently five heats were made up using a 500-lb. high-frequency induction furnace and poured into 7-inch square ingots weighing 375-lbs. each. Fig. 5 shows the 500 lb. melting unit. These ingots gave for the largest tools approximately 8 to 1 reduction. The steel for the 4-inch square ingots was made in a Hoskins carbon pile crucible furnace (Fig. 3) and after teeming the ingots were stripped hot and cooled very slowly in ashes. They were then reheated and forged under a hammer into tools of the desired shape. The ingots made from the 500-lb. high-frequency induction furnace were in general not allowed to go cold, but after stripping from the mold were placed in a hot furnace, soaked the necessary time, and then forged down under a hammer into bars, tools and special shapes.

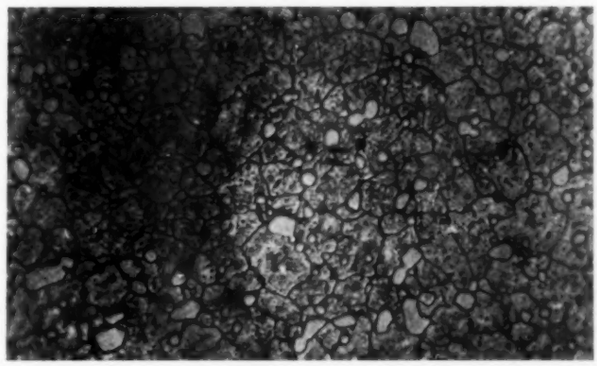


Fig. 6. Structure of Mo. Tool, C.84, Mo. 9.36 Percent, Hardened from 1175°C. Fine-Grained Polyhedral. With Excess Carbides Fairly Distributed. X 1000.

CONSIDERABLE work was performed in developing a satisfactory heat treatment for this steel. The transformation changes are very similar to those of tungsten high-speed, yet in treatment the steels are quite different. The quenching range for the molybdenum was found to run from around 1150°C. to 1200°C. This, it will be noted, is some 100°C. less than for the corresponding tungsten steels. Again, the draw for secondary hardness, while applicable to both, is lower for the molybdenum steel, the maximum limit being around 525°C. as against about 600°C. for the standard tungsten steel. All high-speed steel, of course, should be annealed carefully and thoroughly before hardening.

As little was known relative to the proper treatment of molybdenum steels at the beginning of this work an attempt was made from the start to correlate with the heat treatment, among other things, the micro-structure, fracture test, hardness and performance. As is well known, hardness is not necessarily a criterion of a good high-speed cutting tool. On the other hand, a tool must be harder than the stock it is cutting, and in general it may be said it should be twice as hard. As the molybdenum tools do not attain quite as great hardness as corresponding tungsten tools, for cutting excessively hard stock, say over 300 Brinell, they are perhaps somewhat inferior to tungsten. The fracture test was exceedingly useful. For treatments that gave fine-grained silky fractures the performance was usually satisfactory.

Fig. 6 shows the structure at 1000 magnification of a molybdenum tool hardened from 1175°C. The characteristic polyhedral grain is evident with excess carbides fairly uniformly distributed. Fig. 7 is a photo-micrograph at 500 magnification of a hardened 18 per cent tungsten steel. Again the polyhedral structure is present. Time of etching is one of the most important items to be considered in judging the character of the structure produced by heat treatment. It is well known that the size and distribution of the excess carbides is an important factor in heat-treated, high-speed steel. The structure shown in Fig. 7 is typical of a tool quenched from a very high temperature and the excellent efficiency of this tool was due undoubtedly to the high quench which developed the maximum beneficial effects of tungsten in producing secondary hardening. Apparently the nearer the quenching temperature approaches the solidus point the greater will be the efficiency of any high-speed tool. It would appear that this point is much lower in molybdenum steels than it is in tungsten steels. In order to play safe the average tool hardener is inclined to use a temperature much too low to develop the best cutting qualities of high-speed steel.

A high draw after quenching should be given to improve the life and toughness. It is believed that much work is yet to be done before the very best thermal treatment is found for molybdenum steels.

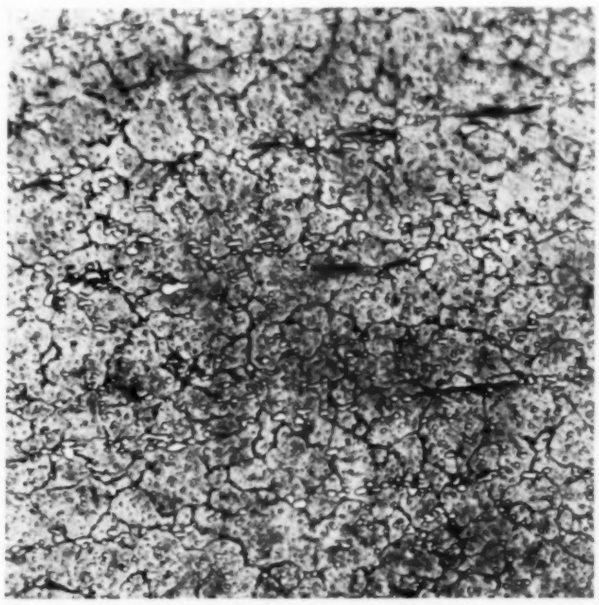


Fig. 7. 18 Percent Tungsten Steel Tool Which Gave Excellent Performance. Polyhedral Structure, High Hardening Temperature. Etched With 4 Percent HNO_3. X 500.

THE chief aim throughout the work was to determine whether satisfactory tools could be made without tungsten. Some tools are better adapted for certain classes of work than others. It has been possible to cover only the general performance of molybdenum high-speed tools. In doing so it was deemed of vital importance to make the tests as broad as possible so that a fair estimate could be formed. Consequently, in addition to breakdown tests, the tools were placed in production service side by side

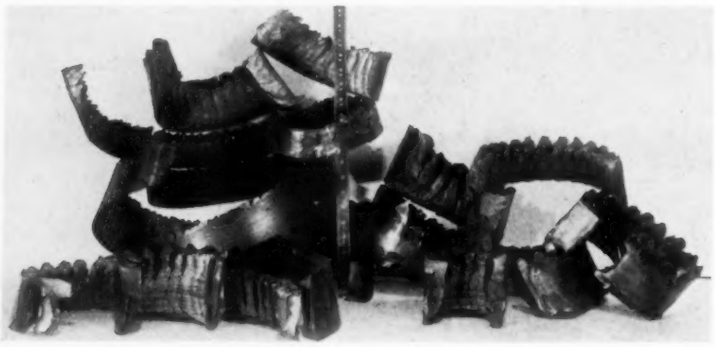


Fig. 8. Some Chips Removed From Castings and Forgings While Testing Molybdenum Tools. (The Scale is in Centimeters).

with regular and standard shop tools on as wide a variety of work as possible, soft and hard, ferrous and non-ferrous, forgings and castings, heavy duty and light duty. Not only lathe and planer tools of various sizes but also special form cutters, such as endmills, reamers, twist drills, milling cutters, etc., have been made up and tested. In addition, special tools as called for have been sent to other ordnance manufacturing plants and samples of the steel have been furnished some commercial tool-steel manufacturers for such tests as they might care to make to ascertain the degree of performance. At this writing there are in the shops at Watertown Arsenal a great many of these tools in production service side by side with the regular tungsten shop tools. In general, they are giving satisfactory performance, comparable with the standard tools. Fig. 8 shows some chips removed from castings and forgings in test and production work by molybdenum tools.

So far only a few partial reports have been received on tools sent away for test, all of which have been exceptionally gratifying. The following is extracted from one of the reports. The makers of the regular steels are not given for obvious reasons. They are referred to in the tests as steels "A," "B," "C," "D," "E," "F," and "G":

"Certain Watertown tools were tried out on the rough and finish machining of the 3-inch antiaircraft Mark IX shell, the 105-mm. shell and the 155-mm. shell, in comparison with tools made of high-speed steels, which steels are considered to be of the best quality obtainable.

Test A

"(1) Rough turning operation on the 3-inch antiaircraft shell ¾ x ¾-inch 'C' tool steel used with the following results:

95 pieces on first grind;
105 pieces on second grind;
139 pieces on third grind.

Watertown tool steel, ¾-inch:
352 pieces on first grind;
182 pieces on second grind;
287 pieces on third grind.

"(These tools were ground with approximately 25° clearance and a 10° lip).

"(2) Rough turning operation on the 3-inch antiaircraft shell—¾ x ⅞-inch 'B' tool steel used with following results:

170 pieces on first grind;
258 pieces on second grind;
280 pieces on third grind.

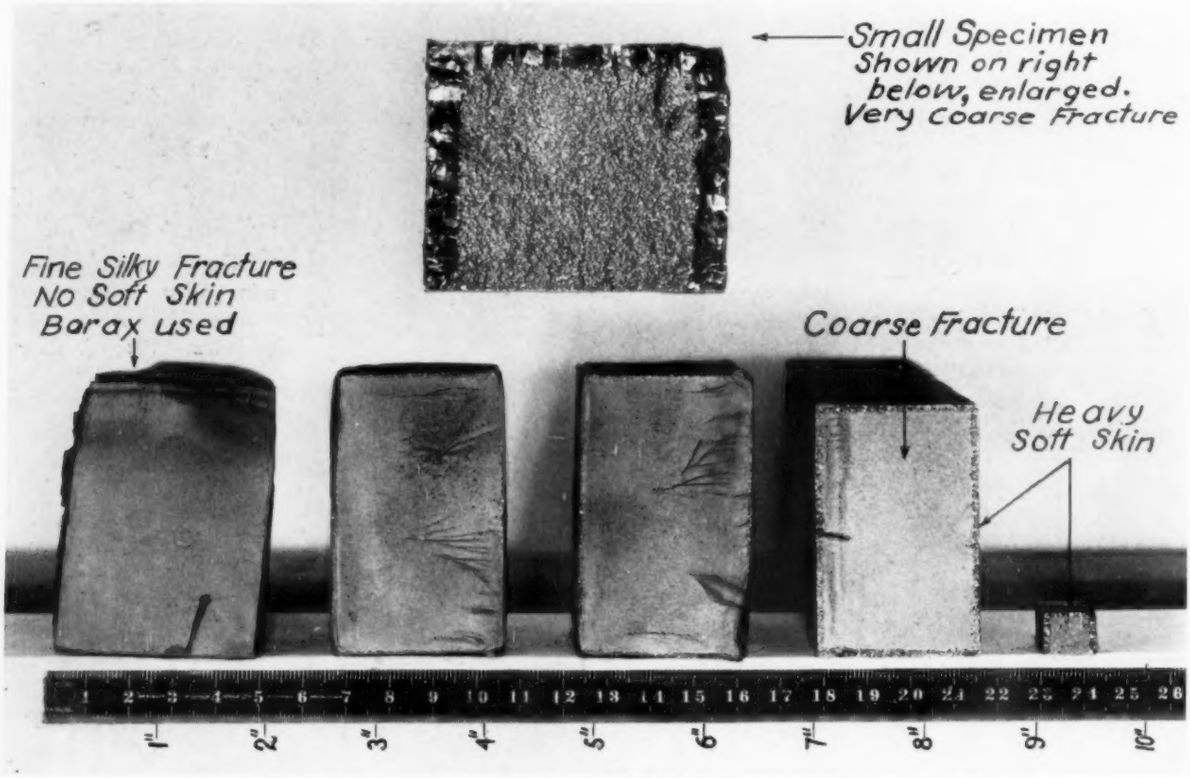


Fig. 9. Photograph of Tools Broken Showing the Soft White Layer and Difference in Fracture.

Watertown tool steel, ¾ x ⅞-inch:
870 pieces on first grind;
361 pieces on second grind;
315 pieces on third grind.

"(These tools were ground with approximately 15° clearance and a 5° lip).

"The steel used in the shell forgings was of a .45 to .65 carbon steel of standard specifications of shell forgings manufactured during the war.

Test C

"(1) Finish turning operation on 3-inch antiaircraft shell manufactured from war-time forgings in which the carbon runs from .45 to .65. After heat treatment the elastic limit runs from approximately 65,000 to 80,000 lbs. per square inch. 7/16-inch square 'B' steel used with following results (Same shell as used in above tests):
34 pieces on first grind;
22 pieces on second grind;
39 pieces on third grind.

"(2) 'D' Steel, 7/16-inch:
11 pieces on first grind;
18 pieces on second grind;
24 pieces on third grind.

"(3) 'G' Steel, 7/16-inch:
29 pieces on first grind;
26 pieces on second grind;
24 pieces on third grind.

"(4) Watertown tool steel, 7/16-inch (Tool No. 1):
21 pieces on first grind;
35 pieces on second grind;
19 pieces on third grind.

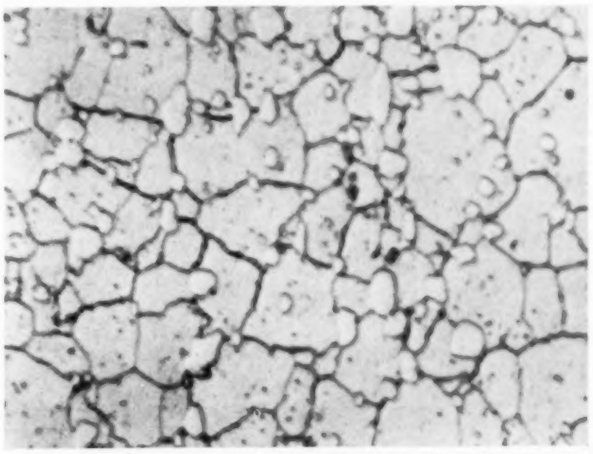


Fig. 10. Photo-micrograph at 1500 Magnification of a Molybdenum-Cobalt Tool Hardened from 1175° C. Although Fracture was Fine-silky, a Higher Quench Temperature Would Probably be Better to Insure More Complete Solution of Complex Carbides. 5 Percent Nital Etch.

"(5) Watertown tool steel, 7/16-inch (Tool No. 2):
37 pieces on first grind;
20 pieces on second grind;
34 pieces on third grind.

"(These tools were ground with approximately 30° clearance and a 10° lip).

Test D

"Machining of 105-mm. high explosive howitzer shell and finish turning operation; forging with .45 to .65 carbon steel specifications, heat treated to physical properties of not less than 60,000 lbs. minimum elastic limit. (These shell were manu-

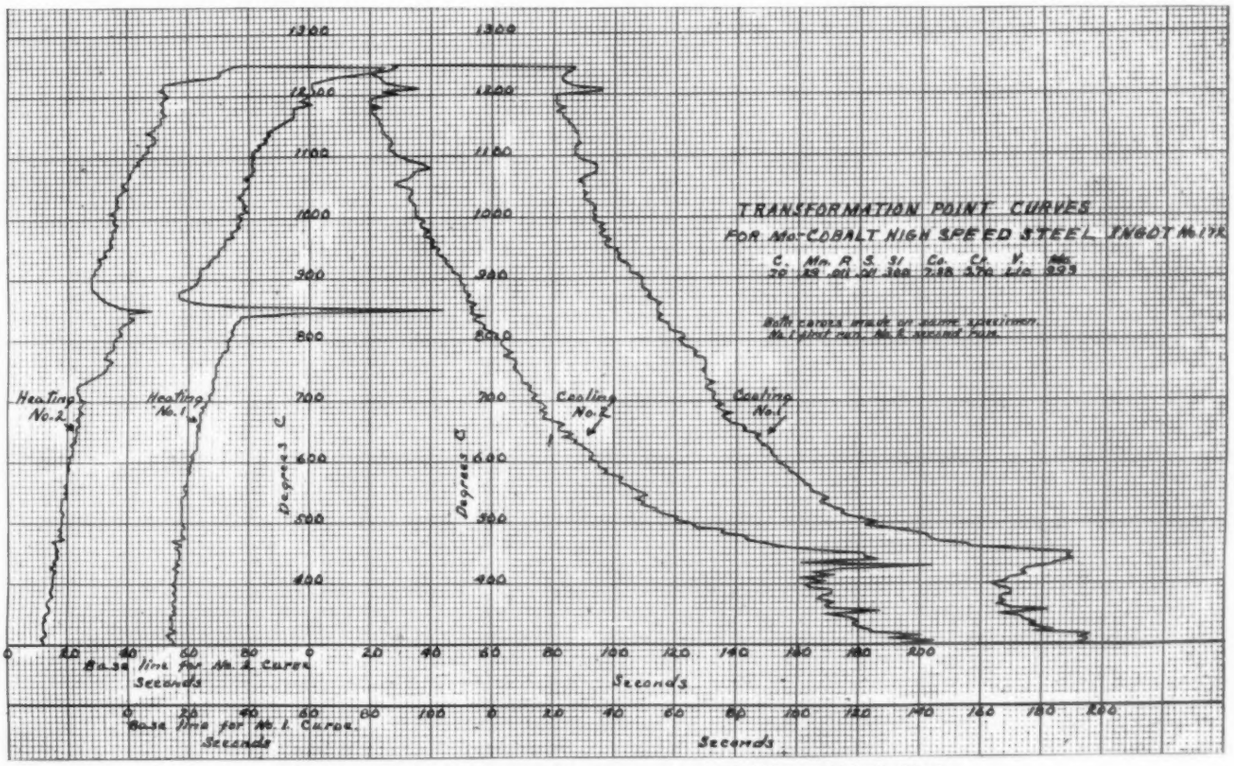


Fig. 11. Transformation Point Curves for Molybdenum-Cobalt Steel.

factured from steel forgings of .59 carbon content and were heat treated to give an elastic limit of 74,000 lbs. per square inch).

"(1) 'A' High-speed steel, ¾-inch square, used with following results (Tool No. 1):
2 pieces on first grind;
2 pieces on second grind;
2½ pieces on third grind.

"(2) 'A' High-speed steel, ¾-inch square, (Tool No. 2):
2 pieces on first grind;
2 pieces on second grind;
1½ pieces on third grind.

"(3) Watertown steel ¾-inch square, (Tool No. 1):
2 pieces on first grind;
2 pieces on second grind;
2 pieces on third grind.

"(4) Watertown steel, ¾-inch square (Tool No. 2):
3½ pieces on first grind;
1½ pieces on second grind;
2 pieces on third grind.

"(These tools were ground with approximately 30° clearance and a 5° lip).

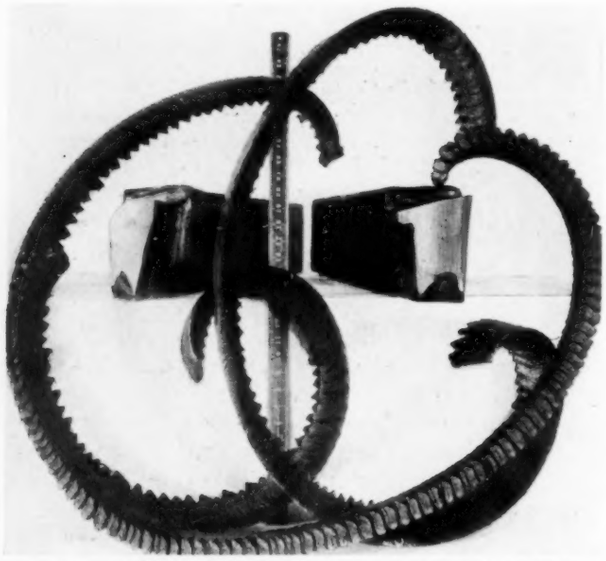


Fig. 12. Tools Tipped with Molybdenum High-Speed Welding Wire, and Chips Removed from Nickel Steel Gun Forgings. (The Scale is in Centimeters).

"From the above test, it is noted that Watertown steel is slightly better than 'A,' which is considered the best grade of steel now used at this arsenal on the above work. * * *

"As a result of these tests, it is the opinion of this arsenal that this lot of Watertown steel is superior to that usually obtained from the leading steel manufacturers."

The following is extracted from a report from another manufacturing plant:

"The 16 special high-speed tools of Watertown Arsenal manufacture were received early in January and put to work. The shops are very enthusiastic over the performance of these tools and are very anxious to obtain more in order that a further and more diversified test may be obtained."

Further test reports will not be reproduced here since this matter is covered more in detail in a paper which it is understood is to be published in *The Iron Age*. Suffice it to say that the general performance of the tools is satisfactory and that, should our tungsten supply become exhausted for any reason, molybdenum could be used instead with little or no loss of efficiency.

ONE of the serious objections to the use of steel containing molybdenum in relatively large quantities has been the formation of a soft skin claimed by some to be due to volatilization of molybdenum. If molybdenum high-speed steel be heated above a red heat exposed to the air a yellowish fume comes off prominently at certain temperatures. The result of such exposure is the formation at the surface of a soft crystalline layer. At high temperatures and long exposures it has been observed to go as deep as ⅛-inch. This, of course, is prohibitive on form cutters and small tools. Fig. 9, is a photograph of some tools broken to show the white layer and the appearance of the fracture. Chemical analyses of this soft layer seem to indicate that it is caused not by a loss of molybdenum, but by decarburization. The carbon loss has run as high as 85 per cent while the molybdenum loss has seldom gone over 10 per cent. Even with ample carbon in the white layer for hardening it apparently will not respond to any heat treatment. At first it was thought it would be necessary to control the furnace atmosphere to prevent oxidation and for a time this was partially done by burning hydrogen in the furnace. This, of course, did not protect the steel while it was being forged. Unfortunately, or fortunately for the success of the investigation, the hydrogen atmosphere failed to give the desired protection, in other words the soft layer still formed, in either the heating or forging operations or both. This fact combined with the objectionable feature of using a gas led to the discovery of a simple and economical method of eliminating the trouble completely in the whole heating and forging process. This consisted merely in coating the steel with a very thin layer of powdered borax somewhat like salt sprinkled on food, which melts forming a thin greasy-looking film that adheres tenaciously, excludes the air and gives complete protection. Some 1500 lbs. of molybdenum high-speed steel were rolled commercially into bars and shapes of various sizes using borax and no trace of the white layer was found. Twist drills, end mills, reamers and other form cutters have been hardened using borax for protection with satisfactory results. For heat treating, a proper commercial bath furnace also should eliminate any trouble in this respect and should give excellent hardening conditions for the steel.

TO ascertain whether this steel could be rolled in essentially the same way as commercial high-speed steel, several 375-lb. ingots of the preferred composition (.68 C. and 9.50 Mo.) were made up and rolled in a manufacturing plant which makes tungsten steels. Bars down to ¼-inch diameter, special shapes, slabs, etc., were forged and rolled successfully. Borax was used and not a trace of the white layer was found. About 1500 lbs. of this steel were recently forged into tools and cutters and hardened. They are in service in the shops at Watertown Arsenal and in general are giving good results. Once the proper technique has been established no difficulty should be experienced in producing molybdenum high-speed tools in any quantities desired.

A great deal is heard today about so-called super-high-speed steels. Usually they are slightly higher in tungsten than the standard 18 per cent and contain, in addition, cobalt up to as high as 10 per cent. While these steels may be superior for some classes of work it is questionable whether for all-round serviceability, where proper balance is maintained between toughness and cutting efficiency, they are any better than the regular tungsten steels. The addition of cobalt of course greatly increases first costs.

It was decided to try out the effect of cobalt additions with the molybdenum steels and an ingot with the following composition was made up, forged into tools and tested.

C.	Mn.	Si.	S.	P.	Cr.	V.	Mo.	Co.
.70	.29	.30	.011	.011	3.70	1.10	9.93	7.38

The tests, while not conclusive, indicate a slight improvement over the straight molybdenum steels. It is understood cobalt-bearing steels are susceptible to soft skins but with use of borax no trouble whatever was experienced. To further these tests three additional molybdenum-cobalt ingots have been made up for rolling in a commercial plant. Cobalt-bearing tools seem to give best results on roughing work. For fine finishing cuts it is doubtful if the extra cost could be justified.

The following table is introduced for comparative purposes to show in tabular form the principal datum points in the history of high-speed steel, the approximate compositions and costs per 100-lbs. of raw materials.

NAME	Mushet Self-Hardening	Taylor-White		Present Average	Super High Speed	Mo-High Speed
Date	1868	1900	Later	1930	1930	1930
Present cost per 100 lbs. raw material	$11.44	$14.78	$28.43	$32.25	$58.30	$18.80
Tungsten	5.50	8.00	17.0–18.0	18.0	18.0–22.0%	.....
Chromium	.30	3.80	5.5–6.0	4.0	4.0%	3.50
Carbon	1.50	1.85	.65–.70	.70	.70–.75	.68
Vanadium	.....	.....	.....	1.00	1.50	1.25
Manganese	1.75	.30	.30	.20	.20	.25
Silicon	1.00	.15	.15	.25	.20	.25
Phosphorus	.....	.025	.025	.025	.....	.025
Sulphur	.....	.030	.030	.03	.....	.025
Molybdenum	.....	.....	.....	.....	.50	9.50
Cobalt	.....	.....	.....	.....	7.0–10.0	.....

Fig. 10 is a micro-photograph (X 1500) of a molybdenum-cobalt tool hardened from 1175°C. It would appear that this is too low a temperature and further work is being done to ascertain the correct treatment for this composition. High-speed steels containing cobalt usually require higher hardening ranges than those without cobalt. Fig. 11 shows two critical point curves for the molybdenum-cobalt steel.

WITHIN the last few years a remarkable contribution has been made in the metal and abrasive cutting industries by the introduction of the tungsten carbide materials. However, to date the field of usefulness of this material is limited. It will require a period of education and transition to appreciate the full value of such tools. The following, quoted from one of the patents issued in 1928 covers briefly the method of manufacture of these tools. "The tungsten metal is to be ground in a ball mill till the grains are less than 1/10-mm. in diameter. This tungsten powder is then heated in a gas furnace using a slight excess of carbon. The resulting carbide is then ground to the fineness of 1/10-mm. and mixed with 50 per cent of its weight of cobalt metal of equal fineness. The two powders are thoroughly mixed in the ball mill and then pressed into desired shapes such as cutting tool parts, heated at 700-1100°C. mechanically worked and then sintered again at 1300-1600°C." A very interesting description of the properties and preparation of tungsten carbide is given in a paper by Owen K. Parmiter, published in *The Iron Age*, March 20th, 1930.

The art of welding has invaded practically every field of metal construction, even into the fabrication of high-speed tools. Not only are tips of the desired size being welded to cheap plain carbon steel shanks, but welding rod of proper composition is being laid on to the tips of these shanks, air-hardened from the welding heat, ground and placed in service without any further treatment. Surprising results have been obtained recently with a plain carbon shank tipped with a built-up weld from welding rod of molybdenum high-speed steel. On cooling from the welding heat a hardness of 600 Brinell has been realized, and, considering the lack of experience in making tools in this way, remarkable performance has been obtained. Fig. 12 is a photograph of tools tipped with molybdenum welding rod with some of the chips these tools removed from heat-treated nickel steel gun forgings.

The foregoing experiments and tests under practical working conditions indicate that: (a) molybdenum can be substituted in whole or in part for tungsten in high-speed tools, and (b) there are no difficulties of manufacture of molybdenum high-speed tools in quantity that cannot be met easily.

The encouragement and active coöperation given by Col. T. C. Dickson, Commanding Officer, Watertown Arsenal, during this investigation made possible the accomplishment of results obtained. Thanks are due also to the laboratory personnel, all of whom contributed directly or indirectly to the results.

Index to Army Ordnance, Volume X

The May-June, 1930, issue of ARMY ORDNANCE, completed Volume X. An index to Volume X, arranged alphabetically and by subject and author, including title page for binding, is available for members and subscribers and may be obtained without cost from the Editorial Office of ARMY ORDNANCE. Readers who have the Journal bound for permanent record should have the index and title page for this purpose. Requests for copies should be addressed to:

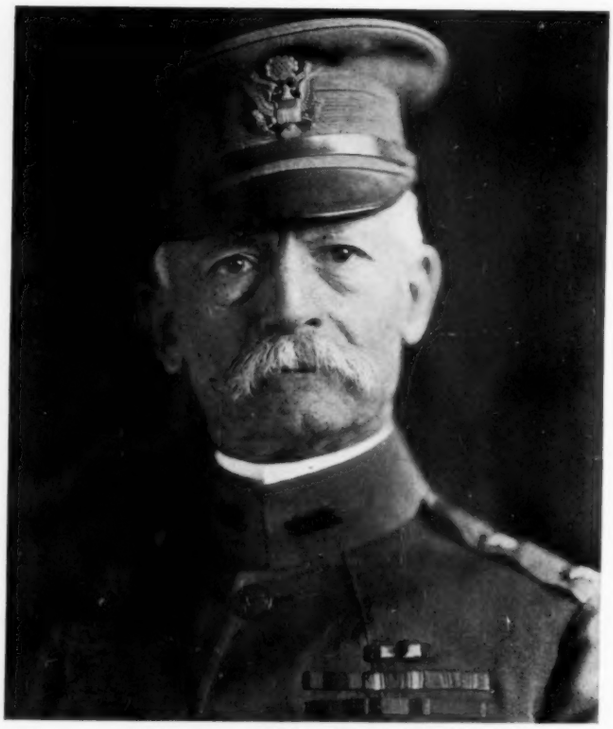
The Editorial Office, Army Ordnance Association, The Mills Building, Washington, D. C.

Our Association's Warrant

An Appraisal of the Function of the A. O. A

By William Crozier

THE limitation of armaments which, as applied to naval forces, was the subject of the Washington Conference of 1921-22, and of the recently concluded conference at London, is not a new matter of international deliberation. It was a prominent feature of the first Peace Conference at The Hague, in 1899, having been stressed in the rescript of the Czar, suggesting the conference, as a pressing measure of relief from the crushing burden of armaments which was bearing hard upon the people of the various nations. It was the first subject taken up at the conference; and, since Russia was mainly responsible for the gathering, the Russian delegates took the initiative in presenting proposals for consideration.



Maj. Gen. William Crozier, Ret.
Chief of Ordnance, U. S. Army, 1901-1918.

The first proposition was that no nation represented at the conference should adopt an infantry rifle of a new model, in replacement of the one with which its forces were armed at the time. This suggestion met with strong opposition from the states whose armies were not yet provided with rifles of the small bore and high velocity of bullet which had then been comparatively recently recognized as distinct improvements; and the proposition failed of acceptance. The United States rifle of the period was the Krag-Jorgensen, an efficient weapon with which it was not dissatisfied. But its delegation voted in the negative, in accordance with the policy of unwillingness to discourage invention, and the belief that such discouragement would not forward the cause of peace or humanity.

The next proposition was to the effect that no nation should adopt a field gun of model more efficient than the best one currently in use in any service. The wording had relation to the new French 75-mm. gun, of long recoil and rapid fire, and was designed to meet the objection of crystalized inequality which was embodied in the rifle proposition. But the proposal was rejected, after much less discussion than had been accorded the first one; which may have been due to the suspicion engendered by the circumstance that Russia was pretty well up-to-date in the matter of the regulation rifle, while her artillery service had not as yet taken advantage of the important development in the field gun. There seemed to be evidence that the Russian General Staff was not in close sympathy with the Czar's peace movement, and the idea gained ground that no suggestions need be expected from Russian sources which did not very well safeguard Russia's military position.

However this may have been, none of the propositions for the limitations of armaments met with any success, and the only restrictions which were adopted were such as had reference to the humanitarian rules of warfare.

A VERY significant feature of the discussion was the revelation of the attitude of France. Upon all the propositions for limitation of armaments and, later on, upon all those for forwarding arbitration and the other peaceful objects of the conference, the French representatives either voted favorably, or else abstained from voting. They opposed none of them. She had sent as military and naval delegates officers of unaggressive character who took little part in the proceedings, while the civilian head of her delegation was the distinguished M. Léon Bourgeois who, with his able assistant, Baron d'Estournelles de Constant, was most active and efficient in all matters relating to the peaceful settlement of international disputes. After having kept Europe anxious for a quarter of a century over her preparations for the forcible recovery of her provinces lost in 1871 it definitely appeared, for the first time, that France had given up the struggle. Her population was stationary. The understanding with England which followed the Fashoda incident of 1904 was still in the future. Her position in Morocco was far from consolidation; and she was no longer spoiling for a fight. The German military and naval representatives, on the other hand, were young and energetic men, very much to the fore in opposition to all measures of restriction upon military action; while her delegation was lukewarm on the subject of arbitration.

The position of France at the conference, however, cannot be accounted a stage reached, even by her, in the development of an attitude towards disarmament, such as may be relied upon as a permanent policy which would justify ourselves and others in turning away from the subject of

munitions design and supply, as a preoccupation from whose necessity the world's longing for peace has freed us. Since the World War the French military machine is the most complete in the world. Indeed she and Germany have almost exchanged places on the stage, though with a different inspiration. Pre-war Germany claimed that her military preparations were defensive, against "encirclement;" but the utterances of her most influential spokesmen, including the Kaiser himself, justify the belief that she was determined to redress the unequal distribution of area of the recently partitioned world which had, truly enough, left her with a share inappropriate for a powerful and cultured nation with good claims to be reckoned one of the great world powers; and there is little doubt that she was preparing to effect the redress by force, if necessary.

The French military effort, on the other hand, is at present defensive, and designed to provide the security against aggression by powerful neighbors which the world at large has been unwilling to guarantee her. Indeed nobody's security is so guaranteed. And no nation has been more positive than the United States in refusing to intervene, for the purpose of keeping the peace, in a quarrel not its own.

WE are all, therefore, still under the necessity of providing individually for our own security; and to do this something like competition in armaments must go on. But we can give the competition a character a little different from that which it had in pre-war time. Progress in design and in standards of manufacture must be governmentally encouraged and provided for, and plans of supply and distribution must be matured and kept up to date. These are functions of the permanent organization of the Ordnance Department. But the war showed that the expenditure of munitions in the full swing of a conflict between great powers is so vast that to attempt to meet it by accumulation sufficient to tide over the interval from normal to required output, after the outbreak of war, would be prohibitively expensive, as well as unwise from the viewpoint of obsolescence. So our plan is to shorten this interval by making an understanding of the requirements of the Ordnance Department a part of the mental equipment of the leaders and executives of industry, and of the body of professional men whose work furnishes the scientific guidance upon which practical production depends. The agency of this plan is the Army Ordnance Association; and it is thought not too much to hope that the interest of the membership may be such as to stimulate invention and the adaptation of plant equipment to the manufacture of munitions, so that the normal condition of industry may not be far removed from that which it is required to assume when meeting the demands of war.

Although the manufacture of munitions of war is not a direct part of the daily duty of industry in supplying the needs of the community in time of peace, the attention to this manufacture which is required by the scheme of the Association should not necessarily be wasted effort, even from the point of view of industry's peace function. The urge for excellence in the most intense competition in which men engage, the competition of war, has brought about many advances in the production of material things which serve the comfort and welfare of mankind. The luxurious and enduring dwelling house has its prototype in the fortified castle of the Middle Ages, and, more recently, the production of steel by methods which could combine the immense output and the superb qualities required for the automobile industry, for example, are owing, in great measure, to the efforts in research and experiment made to meet military demands. Just now we are pushing into commercial activity the art of aviation, whose development received such a tremendous impetus from the World War.

LET us realize, then, that the object and practice of our Association are not incompatible with the progress of the world; and that they do not promote merely destructive force in the moderate attention which they call for, but are comparable, in a way, with the military training of personnel, which such a competent observer as the late President Hadley stated to be more than worth the time devoted to it, in the increased efficiency which it engendered in the young manhood of Germany, the country whose system he had under review. The success of the Association, and the steady increase in circulation of its organ, ARMY ORDNANCE, in its decade of existence, encourage us to believe that our project is in line with the sane thought of the times, when statesmen are trying to adjust armaments to the incomplete ideal of peace, recognizing that, as long as peoples are unwilling to give the guarantees and make the sacrifices which constitute the price for peace, the arbitrament of war is still on the horizon.

Col. Hanford MacNider Chosen Minister to Canada

COL. HANFORD MacNIDER, former Assistant Secretary of War, member of the Army Ordnance Association and national commander of the American Legion in 1921, has been chosen by President Hoover to be Minister to Canada.

Colonel MacNider was born at Mason City, Iowa, in 1889, and is a graduate of Harvard University. He served on the Mexican border in 1916 as a lieutenant of the Iowa National Guard and with distinction in the World War. He was wounded in action September 12, 1918, at St. Mihiel. On October 17, 1918, he was made a major of Infantry, and December 27, of the same year, was assigned as division adjutant of the Second Division and stationed in Germany until the latter part of July, 1919. He won the Distinguished Service Cross with clusters and was also decorated by France and Italy.

Since returning to civil life Colonel MacNider has engaged in banking in his native city, the business with which he was associated before the war. He has long been interested in the development of inland waterways and at the White House it was said that he would carry on the negotiations for the projected Great Lakes-St. Lawrence River development.

President Coolidge appointed Colonel MacNider Assistant Secretary of War in 1925, and he served in that office until 1928.

Is Mechanization Expensive?

Cost Analysis Reveals Great Economy of Machine Warfare

By John K. Christmas*

THERE is a great deal of discussion of mechanization now-a-days; this is promising, but unfortunately there seems to be considerably more argument than investigation. Like all new ideas, mechanization is meeting with its share of opposition from the "it-can't-be-done" school, many of whom are of the type who early in the 19th Century proved mathematically that a steamship couldn't cross the Atlantic. Usually the last resort of the opponents of a mechanized army is this: "Well, even if mechanization has some military merits it is too expensive; how can you expect Congress to provide us with enough $25,000 tanks, even for our peace army?" Therein lies the specious argument and this article is an attempt to show just how specious it is; for, as will be shown, *mechanization is a great economy.*

Table A

(1) *Fire Efficiency of an Infantry Regiment.*

Weapons	Max. Rate of Fire[1]		Max. Rate of Fire per min.
3 guns, 37-mm....	50	lbs./min.	150
36 guns, machine, caliber .30....	12.3	lbs./min.	442
3 mortars, 3-inch.	165	lbs./min.	495
1,852 rifles, caliber .30.....	0.246	lbs./min.	456
162 rifles, automatic, caliber .30.	2.95	lbs./min.	478
995 pistols.....	0.66	lbs./min.	657
Total fire power of an infantry regiment.....			2,678 lbs./min.

$$\text{Fire efficiency} = \frac{\text{lbs. fire—min.}}{\text{No. men engaged}} = \frac{2,678}{3,106} = 0.86 \text{ lbs./min./man.}$$

(2) *Fire Efficiency of a Light Tank Battalion.*

Weapons	Rate of Fire	Rate of Fire per tank
45 light tanks, T1E2[2].....	50 lbs./min.	2,250

$$\text{Fire efficiency of tank battaion} = \frac{2,250}{534} = 4.22 \text{ lbs./min./man. (normal)}$$

or

$$\frac{3,600}{534} = 6.75 \text{ lbs. /min./man. (maximum)}$$

1. The maximum rate referred to is the normal, or the accepted service, maximum rate.
2. Each tank is equipped with a 37-mm. semiautomatic gun and a caliber .30 machine gun, in a combination mount, either of which may be fired at one time.
There are also 27 tanks in reserve which could be used concurrently with the others, giving a maximum possible fire power of 72 x 50 or 3600 lbs. min. One tank in battalion headquarters not considered.

Due to the manner in which funds for the Army are appropriated and accounted for it is not easy to arrive at true costs, that is, costs from a "production" standpoint. Of course, in industry there is always a product or service to the unit cost of which all expenditures contribute. That is, a motor car costs so much to produce, a kilowatt of electric power costs so much to generate, or transportation costs so much per ton per mile. The Army is not generally considered to have a "product" or "service" to sell, but it has, viz., the destruction of the enemy.

Before attacking the problem of the cost of mechanization we must, therefore, arrive at a unit of value by which to measure the combat organizations of an army in terms of power to destroy the enemy. "Field Service Regulations, U. S. Army 1923" state (p. 77) "The *ultimate* objective of all military operations is the destruction of the enemy's armed forces by battle;" and again (p. 84) "Superior fire constitutes the best protection against loss as well as the most effective means of destruction." The general chapter in the regulations on "Combat" may be epitomized in the expression "fire and movement, constitute the basis of successful combat." Disregarding in this study any claims of superior mobility and better protection against casualties in mechanized units we may, therefore, fairly compare the combat efficiencies of units by their fire power, i. e., the maximum pounds of projectiles which they can discharge against the enemy per minute.

THIS method of computation, based on the organization and equipment laid down in the latest Tables of Organization, gives results shown in Table A for a war-strength infantry regiment and a war-strength light tank battalion:

Table A shows that when both combat units are putting forth their maximum efforts the light tank battalion has a fire power that is $\frac{3600}{2678}$ or 1.34 times that of the infantry regiment. For purposes of comparison and fairness to the infantry unit it has been assumed that all weapons issued to that unit are employed at the same time; in the case of the tanks only the 37-mm. guns in the tanks are assumed to be firing. However, in actual combat some weapons would be held in reserve.

It is interesting to note from Table A that, *per man risked in combat*, in the tank unit we obtain $\frac{6.75}{0.86}$ or 7.85 times as much fire power as in the infantry regiment. That is, the tank unit conserves personnel and thus greatly reduces casualties. For the purposes of this study we may therefore, in all fairness to the infantry regiment, regard a light tank battalion as its equal in fire power and general combat efficiency. In other words, just as horsepower is the basis on which a gasoline engine is rated and its value determined, so the *fire power in pounds of projectiles fired per minute* is a true index to the relative assault value of military combat units, if mobility and protection are assumed equal.

The next question that naturally arises is then: if these two units are equal in fighting power which has the lower maintenance cost? What is the cost of maintenance per pound fired per minute? Since the Army has been built up gradually; as its *total* cost is usually the principal issue in appropriations; and as it is not operated for profit the system of accounting does not readily lend itself to the de-

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termination of true unit costs per man, or per company or regiment.

Rather, we are used to having an army of say 115,000 men for which separate appropriations are given for pay, clothing, food, medical service, quarters, and combat equipment. When we of the Army think of a regiment we think of the men as in a way being there anyway while their fighting equipment is a heavy expense and must be kept to a minimum. We think first of the fighting units as so many men, and then of the necessary weapons. The first thought should be of so many fighting weapons and then of the necessary personnel to man the equipment. The Navy does not say that they must have another cruiser with which to equip a certain number of men who are now idle; they say another cruiser is needed, which if built will require so many additional men as a crew. The emphasis there is first on the equipment.

There are many who think as one officer who said: "You can carry two men per tank, that is 500 tanks to carry a small regiment, or $125,000,000 for equipping a mechanized regiment. It will thus cost $12,500 to transport one man!" Well, if the Navy were to look at it that way, a $35,000,000 battleship, like the *Maryland*, with a crew of about 1,400 men figures out at $25,000 to transport one fighting man! And combat airplanes cost $15,000 to $35,000 per man carried! The point is, of course, that transportation in all these cases is only incident to the combatant power; the machine does the fighting (or work) with the crew to direct it, as in industry.

However, let us approach the subject in a different manner. It costs the United States Government (and taxpayers) about $1,100 per year to pay, clothe, feed, house and generally maintain a soldier. (Hearings, W. D. Appropriation Bill, 1928). Using this figure and other costs taken from official price lists, Congressional hearings and the annual estimates, the annual cost of maintaining an infantry regiment and a light tank battalion may be computed with a fair degree of accuracy.

WE have seen that in fire power or combat efficiency an infantry regiment is approximately equal to a light tank battalion. Their total personnel and the annual costs thereof are about as follows:

Table B

Annual Maintenance Costs of Personnel.

Infantry Regiment	*Annual Cost Each*	*Total Annual Cost*
121 officers	$5,000[1]	$ 605,000
2,985 men	1,100	3,283,500
		$3,888,500
Light Tank Battalion		
29 officers	$5,000	$ 145,000
505 men	1,100	555,500
		$ 700,500

1. This estimate includes the average pay and allowances, equity in retirement and all other costs incurred in maintaining an officer.

Table B shows that, contrary to our common belief, soldiers are not cheap. "Muscle-propelled" units run into enormous costs due to the large numbers of men required to get the necessary fire power and "surviving" power. By "surviving" power is meant the protection inherent in an infantry regiment due to the division of its fire power into many small *unprotected* units (men), the small surviving portion of which accomplish the mission of the attack. The next step is to see what it costs annually for the Government to maintain a light tank battalion. The infantry regiment thus far has an unfavorable balance, as regards personnel, of $3,188,500 as compared with the tank unit.

Table C

Cost of Major Matériel for an Infantry Regiment.

(1) *Animals:*

141 horses, riding
334 mules, draft
17 mules, riding

492 animals at $165.00 = $81,200 (initial cost)
$81,200 x .08 = $6,500 annual depreciation, cost of animals;
492 x $115. = $56,580 cost of forage, etc.;
492 x 5.00 = 2,460 cost of shoeing, etc.;

$65,540 annual maintenance cost of animals.

(2) *Harness:*

158 riding at $50.00 = $ 7,900
176 draft at 49.00 = 8,624
158 draft at 32.00 = 5,056

Total ..... $21,580 (initial cost)
Annual depreciation and maintenance of harness at 30 per cent = $6,474.

(3) *Vehicles:*

7 cars, cross country	at $ 900.	= $	6,300.
1 car, motor, 5-passenger	at 900.	=	900.
18 kitchens, rolling	at 668.	=	12,024.
6 motorcyles, with side-car	at 428.	=	2,568.
2 trucks, cargo, ¾-ton	at 1,200.	=	2,400.
1 truck, cargo, 1½-ton	at 2,000.	=	2,000.
14 wagons, combat	at 175.	=	2,450.
30 wagons, escort	at 172.	=	5,160.
Total cost			$33,802. (initial cost)
Depreciation at 15 per cent on $33,802		=	$5,070
Maintenance and operation (on motor vehicles only) at 10 per cent		=	1,417
Total			$6,487

(4) *Ordnance Equipment (Weapons):*

	Initial Cost, Each		*Maintenance Cost, Each*	
36 carts, ammunition, machine gun at	$ 80.	= $ 2,880.	$ 3.00	= $ 108.
3 carts, ammunition, mortar at	80.	= 240.	3.00	= 9.
3 carts, ammunition, 37-mm. gun at	80.	= 240.	3.00	= 9.
5 carts, communication at	84.	= 420.	3.00	= 15.
36 carts, machine gun, cal. .30 at	300.	= 10,800.	25.00	= 900.
3 guns, 37-mm. at	1,215.	= 3,645.	30.00	= 90.
3 mortars, 3-inch at	112.	= 336.	15.00	= 45.
995 pistols at	26.	= 25,870.	.35	= 348.
1,852 rifles at	37.	= 68,524.	1.10	= 2,037.
162 rifles, automatic at	115.	= 18,630.	3.00	= 486.
		$134,861.		$ 4,164.
Depreciation, 10 per cent				13,486.
				$17,650.

The comparative initial costs of the equipment are prop-

Table D

Cost of Matériel for a Light Tank Battalion.

	Initial Cost Each	Total Cost
(a) *Vehicles:*		
1 ambulance, motor	$1,500.	$ 1,500.
5 cars, cross country	900.	4,500.
1 car, motor, 5-passenger	900.	900.
4 kitchens, rolling	668.	2,672.
10 motorcyles, with sidecar	428.	4,280.
4 trailers, 4-wheel, water, 250 gal.	500.	2,000.
6 trucks, cargo, ¾-ton	1,200.	7,200.
73 trucks, tank carrier	6,000.	438,000.
16 trucks, 3-5-ton	3,500.	56,000.
3 trucks, tank, gas, 750-gal.	3,000.	9,000.
		$526,052. (initial cost)
Depreciation at 15 per cent		$ 78,907.
Maintenance and operation at 10 per cent		52,605.
Total annual cost of vehicles		$131,512.

(b) *Ordnance Equipment (Weapons):*	Cost, Each		Maintenance Each	
73 guns, machine, caliber .30	$ 300.	$ 21,900	$25.00	$ 1,825.
73 guns, 37-mm.	1,215.	88,695	30.00	2,190.
515 pistols	26.	13,390	0.35	180.
		$123,985		$ 4,195.
Depreciation (10 per cent or $123,985)				12,399.
(Total maintenance cost)				$16,594.

(c) *Tanks:*	Cost, Each	Total
73 tanks	$ 25,000	$1,825,000
Depreciation at 10 per cent	$182,500	
Maintenance at $300. each	21,900	
Operation (training, 50 hrs—yr.) at $1.00 per hr.	3,650	
Total annual maintenance cost of tanks	$208,050	

Note.—In comparing maintenance and operation of tanks and of wheeled motor vehicles it must be remembered that the wheeled vehicles are operated much more than the tanks. In this study all tanks are assumed to be used for training; actually 45 are in use and 27 in reserve.

Table E

Initial Costs (of Equipment)

Item	Infantry Regiment	Light Tank Battalion
Animals	$ 81,200	.....
Harness	21,580	.....
Vehicles (Q. M.)	33,802	$ 526,052
Weapons	134,861	123,985
Tanks	.....	1,825,000
	$271,443	$2,475,037
Interest on initial cost at 4½ per cent	12,215	111,377

Table F

Summary of Total Annual Maintenance Costs.

Item	Infantry Regiment	Light Tank Battalion
Officers	$ 605,000	$ 145,000
Enlisted men	3,283,500	555,500
Animals	65,540	.....
Harness	6,474	.....
Vehicles (Q. M.)	6,487	131,512
Ordnance equipment (weapons)	17,650	16,594
Tanks	.....	208,050
Interest on initial investment	12,215	111,377
	$3,996,866	$1,168,033

erly carried into the annual maintenance costs, as would be done in a factory, by including the interest on the money invested, that is, the interest on the initial cost, as shown in Table E. This cost plus depreciation and ordinary maintenance costs make up the *total annual costs.* The whole study is summarized in Table F.

Table F summarizes the results of this study, which results are a clean financial victory for the tank unit. *It costs over three (3.42) times as much to maintain an infantry regiment as a light tank unit, although the two units are of equal fighting value.* (This is only true if the armor protection afforded the personnel and the extra mobility of the tank unit are discounted, as they have been in this paper to avoid controversy on factors difficult to evaluate numerically).

As it may be argued that the figure of $1,100 per enlisted man for annual maintenance is too high, or can be reduced by special efforts, let us see *how low* the cost per man must be to make the two units, which are equal in fighting power, equal also in total annual maintenance cost.

	Annual Cost of Equipment	Annual Cost of Officers
Light tank battalion	$467,533	$145,000
Infantry regiment	108,366	605,000
Excess cost of officers for infantry regiment		460,000
Excess cost of equipment for tank battalion		359,167
Excess annual cost of an infantry regiment for *equipment and officers only*		$100,833

It can be seen, therefore, that *even if the enlisted men cost absolutely nothing to maintain* the light tank battalion is a cheaper unit to maintain than an infantry regiment. There will, of course, be criticisms of the figures used here; mathematical accuracy is not claimed for them but I believe they are correct within 10 per cent. The enormous difference in cost shown here makes, I think, an excellent case for the light tank unit as a superior combat unit of the national defense from an expense standpoint; in shock power, mobility and protection, the light tank unit also has great advantages which have been discussed in other articles.[1]

We can thus see that mechanization in peace is not as excessively expensive as is generally thought, and mechanized units are actually cheaper than non-mechanized units. Questions concerning the merits and demerits of mechanization should, I believe, be considered with this in mind.

Editor's Note: For collateral data relating to the general subject, the mechanization of armies, readers are referred to the following articles which appeared in recent issues of Army Ordnance: "Mechanization and Military History," by Hoffman Nickerson (Vol. X, No. 55, p. 19); "Mechanization and Realization," by Brigadier J. F. C. Fuller (Vol. X, No. 45, p. 90), and "Mechanization in Europe," by C. C. Benson (Part I, Vol. X, No. 55, p. 29, and Part II, Vol. X, No. 57, p. 158).

1. Christmas, John K., "The Mechanization of Armies," *The Military Engineer*, July-Aug. and Sept.-Oct. 1929.

The Ordnance Specialists' School

An Institution for Field Service Training

By H. B. Sayler*

THE necessity for having trained officers and men to provide for proper supply, storage and maintenance of ordnance matériel has long been recognized but it was not until after we entered the World War that the demand for these trained ordnance men became so great as to require the establishment of special schools to accomplish their training. To meet this need several schools were created such as the Machine Gun School at Sandy Hook, N. J., and Motor Instruction School at Peoria, Ill.

Shortly after the close of the war these various schools were discontinued and in the early part of 1919 the Ordnance Operations, Maintenance and Repair School was established at Raritan Arsenal, retaining this name until September 1, 1921 when it became the Ordnance Specialists' School. The present name implies that the chief purpose of the school is the training of ordnance enlisted men for the specialists grades but this is only partially true for the objects of the school as provided in Army Regulations are: (a) To instruct and train officers, warrant officers, and enlisted men in the specialized duties and requirements of the ordnance field service of the Ordnance Department. (b) To study, prepare, and compile the charts, tables, lists and training regulations required by the ordnance field service. (c) To standardize and coördinate the instruction and training of enlisted specialists of the Ordnance Department, and to establish and maintain the basic standards of proficiency required of such specialists. (d) To supervise all matters pertaining to the vocational instruction and training of enlisted men of the Ordnance Department. In addition to the above, the preparation of technical regulations has been recently assigned.

It will be noted from the objects set forth above, that the school is in reality a field service activity and inasmuch as it is charged with the training of officers as well as enlisted men for the non-commissioned staff, its present name is not accurate in describing its objectives and as it is felt that the training of officers and non-commissioned officers is of equal importance to that of enlisted specialists, it will probably be rechristened the Ordnance Field Service School in the near future.

To accomplish its prescribed mission in respect of instruction, three officers,' four non-commissioned officers,' and twelve enlisted specialists' courses are prescribed. For officers, there are the maintenance, depot, and ammunition courses, each of twelve weeks duration. Courses for non-commissioned officers last twenty weeks and are in maintenance, administration, depot, and ammunition.

There are twelve enlisted specialists courses, each of 40 weeks duration as follows: armorer, blacksmith, carpenter, clerk, electrician, equipment repairman, machinist, artillery mechanic, auto mechanic, munitions worker, sheet metal worker.

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To perform its functions the school is divided into three main divisions which are the Administration, the Instruction, and the Field Service.

THE Administration Division is what the name implies and does not differ greatly from that of any other establishment. It consists of the registrar's office and the property, mail and record, accounting and maintenance sections and a section for handling the records pertaining to military personnel. The records of students are kept sufficiently complete as to show where the student has been at any period and what subject was being covered at the time as well as his grade on every job pertaining to his course and weekly ratings covering his attitude, manual ability, understanding and development. This is a function of the school registrar. The secretary of the school is the property officer and is therefore accountable and responsible for all school property which requires about 12,000 stock record cards for the purpose.

The Instruction Division consists of seven departments, each under control of an officer known as the department director.

a. The Military Department. A fundamental policy of the Ordnance Department is that all ordnance enlisted men should be good soldiers and with this in mind the military department strives to instill in all students those basic characteristics and that fundamental knowledge a man must possess to meet this requirement. Instruction includes close order drill, honors, salutes and courtesies, guard duty, ceremonies, care of equipment, personal hygiene, sanitation, convoy duty and camping, and especial effort is made to create and develop leadership and instructor abilities.

b. The Academic Department. This department might be called a necessary evil. Inasmuch as a number of the students have not the basic educational qualifications to pursue there vocational courses as efficiently as is desirable, it has been found necessary to instruct such men as fail to pass a preliminary examination in those basic subjects, such as reading, writing and arithmetic, to give them the basic education required to carry on their other work.

c. The Service Department. This department is responsible for the training of welders, machinists, carpenters, blacksmiths, sheet metal workers and a portion of the work given the non-commissioned officers who pursue the maintenance course. In addition to these it teaches all mechanics, in the floor and bench section, the use of metal-working hand tools such as hammers, chisels, files, scrapers, soldering irons and the like. The woodworking section conducts a short course in packing and crating ammunition for the students in the munitions workers' course.

Much practical work can be utilized for instructional purposes in this department and the many useful and necessary repairs as well as new construction and the manufacture of new articles which are needed from time to time not only creates considerable interest on the part of

Automotive Department, Ordnance Specialists' School.

all concerned but also saves the Government quite a large sum of money.

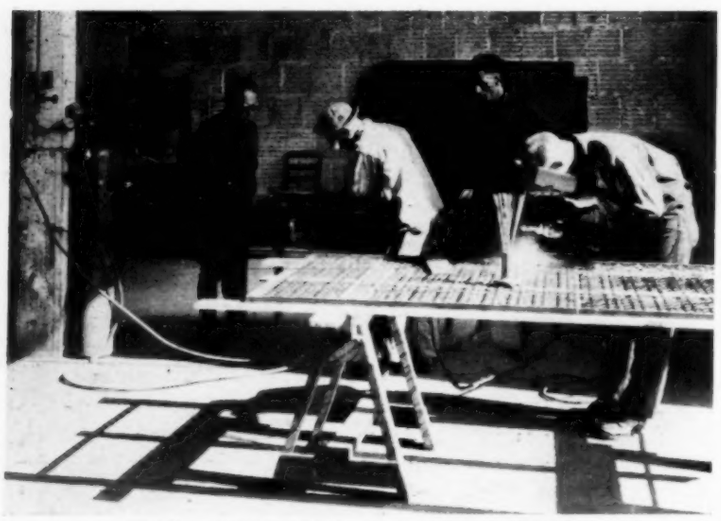
The equipment provided for this instruction is exceedingly complete and well arranged and comprises chiefly those machines, tools, etc., which the student will most likely have available in the field or at peace-time stations of ordnance units.

d. The Armament Department. The problem of how to make artillery, ammunition and small arms interesting studies for enlisted men is one of the main concerns of the armament department which has for its principal purpose the training of artillery mechanics, ammunition workers, and armorers. A satisfactory solution of this problem is made easier by the fact that nearly everybody has an intrinsic interest in guns and bullets but the problem is made harder because the great mass of detailed knowledge and manual dexterity which a competent ordnance maintenance man must have is acquired only by patient study and tedious repetition. The plan of instruction, therefore, is to give an exact training in standard nomenclature, assembly, functioning, inspection, storage, and repair and at the same time add interest and freshness by introducing into the courses as many features of variety and popular interest as possible. These features include a synchronized aircraft machine gun mounted indoors where each student can fire it, illustrated lectures on the history of the matériel being given, a 200-yard outdoor test range with a mechanical rifle rest where students can see the actual performance of a rifle which they have inspected visually or by gage, practice repair work on unserviceable material shipped in from the field, and trips to other ordnance establishments where work of related interest is being done.

Increasing importance is attaching to the armament department because of the courses in ammunition, artillery, and small arms which it gives each year to a class of officers as a part of Course II of the Ordnance School. The work given by the armament department covers at present about nine weeks. The aim of this course has been to make each officer familiar with the ordnance equipment which he is likely to meet in the field. In the past, much embarrassment has not infrequently been suffered by presumably well trained ordnance officers who, for instance, walked up to a French 75 in a line organization and could not get the breech block open until some recruit kindly pressed on the operating handle plunger. These occasions arose, of course, from the fact that the types of ordnance have become so numerous that the individual officer was not likely to be familiar with all of them until a special opportunity for a study of matériel was provided. Reports indicate that this training has borne good results already.

e. The Automotive Department. The importance of keeping transportation in good running condition cannot be over emphasized and in the Army this is an increasingly difficult problem due to the fact that practically all the vehicles on hand were procured during the war and are now ten or more years old. It is the aim of this department to give the students assigned thereto the necessary knowledge to keep these vehicles running and instruction therefore includes shop repair, road repair and driving.

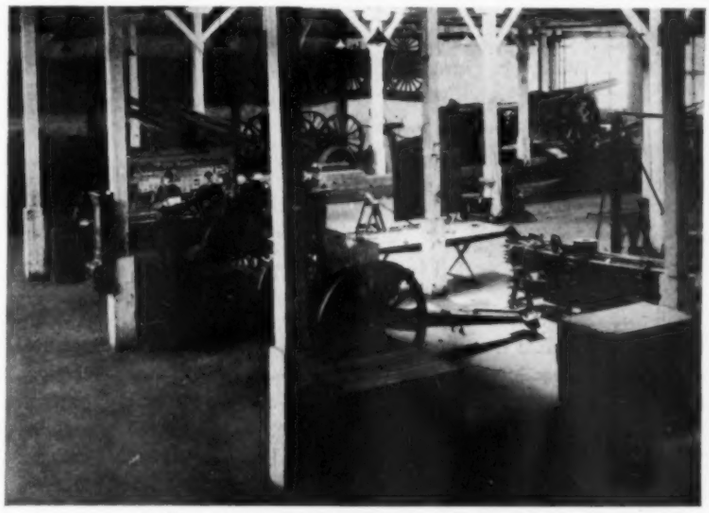
f. Correspondence Department. The correspondence department prepares subcourses on ordnance field service subjects for incorporation in the Army Correspondence Courses. These courses are designed for home study by reserve officers to enable them to prepare for their war-time duties and to qualify for promotion. This work involves the selection of texts from Ordnance Department literature and other official documents, the actual writing of textual matter adapted from sources such as reports of ordnance officers in the A. E. F. and mobilization plans, and the preparation of the necessary lesson exercises, examinations and approved solutions. The conduct of the courses, enrollment of students, and grading of papers, are not functions of the Ordnance Specialists School, but of officers on duty with the Organized Reserves at corps area headquarters and ordnance district offices.



Welding Section, Ordnance Specialists' School.

g. The Special Courses Department. From time to time the school has been directed to

give special instruction to certain individuals or groups covering limited subjects only and the supervision and coördination of this instruction is the function of this department. Each year a class of about ten petty officers of the Navy is given a five week's course on aircraft armament. The course given the officers who come each spring to the school from Watertown Arsenal is under this department as these officers are not present long enough to take one of the regular officer's courses. In the past special instruction in maintenance and preservation of armament has been given to certain enlisted men of the line and a few individual officers have been given short courses in supply and maintenance just prior to their departure for foreign service. During the annual maneuver of the school troops, who are formed into a provisional maintenance company, a special course of two weeks' duration is given such officers of the organized reserves as may be ordered to the school for their active duty training.



Artillery Section, Ordnance Specialists' School.

PRIOR to the World War, and during the early stages of the participation of the American forces therein the old property return system, the system of invoices and receipts, balance of stores, report of unfilled requisitions, etc., was in effect. A study of the provisioning system in effect in the British Army was made and this system was put into effect in the Ordnance Department of the American Army in France early in the spring of 1918 and the old systems were abolished. Briefly, the ordnance provisioning system is the means by which the depots and arsenals are provided with the necessary stocks of supplies, and which furnishes the information to the central procuring office on issues of supplies and stocks on hand.

After the war the ordnance provisioning system was put into effect throughout the Ordnance Department and in connection therewith the compiling and publishing of standard nomenclature lists, at that time called review lists, was undertaken as an essential feature of the proper functioning of this system. A small force was assigned to this work with offices in the Ordnance Department at Washington. The standard nomenclature lists, or review lists as they were then called, were at that time simply alphabetical lists of parts and equipment. Their primary purpose was for use in making up reviews, the latter being a report of issues, receipts, stock on hand and such other data as was pertinent thereto.

In July, 1920, this force was transferred to Rock Island Arsenal, increased, and, with the equipment available for a physical check and better working facilities, the compiling of the lists was continued. The office remained at Rock Island Arsenal until July, 1921, when, due to the desire on the part of the authorities to have the office closer to the central office in Washington, and other reasons, it was transferred to Raritan Arsenal as the field service branch office.

The field service branch office as originally organized at Raritan Arsenal operated directly under the Chief of Field Service in Washington, the arsenal exercising only perfunctory administrative and disciplinary supervision.

After the transfer to Raritan Arsenal the duties were enlarged to include the compilation of ordnance equipment charts, covering the various articles of equipment issued to the different organizations of the Army, the standardization of ordnance nomenclature, and the publishing in various forms of instructions and procedure relative thereto. It maintained a close liaison with the using branches of the service, and coördinated their views with those of the technical branches of the Ordnance Department. It acted as a sort of clearing house for the ordnance provisioning system and continued to compile and issue to the various ordnance establishments throughout the country instructions relating to procedure and standardization of material under this system. These instructions were generally in the form of standard nomenclature lists.

On July 1, 1923, the Ordnance Department transferred the field service branch office to the control of the Commanding Officer, Raritan Arsenal, the personnel to continue on its present work under the immediate supervision of the assistant commandant of the Ordnance Specialists' School.

Armory Section, Ordnance Specialists' School.

Orders were to be issued from time to time by the Ordnance Department through the Commanding Officer, Raritan Arsenal, covering the future activities of the section.

Effective June 1, 1925, the designation field service branch office was abolished and field service division substituted therefor and transferred to the control of the Commandant. This designation has remained although the duties and activities of the office have been added to and greatly enlarged upon until at present the division is carrying on as follows:

a. The maintenance of necessary reference files, drawing files, record of standard prices, files of commercial catalogues and all data necessary in its operations.

b. The preparation and distribution of standard nomenclature lists, ordnance provisioning system regulations, and changes thereof.

c. The preparation or arrangements for preparation of War Department Technical Regulations assigned to the Ordnance Department.

d. The preparation of weights and volume data.

e. The preparation of handy reference data for the inclusion in field service staff manual and other War Department publications.

f. The preparation of ordnance equipment charts, tables of organization, tables of equipment, tables of basic allowances and tables of allowances.

g. The preparation of the ordnance catalogue and schedules of reviews.

h. The study and preparation of standard practice and glossary.

i. The preparation of such as may be necessary, and reproduction and distribution of all field service modification work orders.

j. The preparation of field service war plans data.

k. The operation of duplicating and other reproducing machines.

l. The standardization of equipment and supplies.

m. The preparation of all correspondence pertaining to the above, and such other matters as may be assigned.

Standard nomenclature lists are now entirely different publications from what they were originally. They cover the alphabetical lists of parts, assemblies, and equipment; quantities; prices; plates and figures with necessary indentification symbols; symbols indicating expendable and non-expendable items and repair material; all items are classified according to the nature of repairs to be made, that is, whether replacement can be made by line personnel, ordnance maintenance companies, larger and more completely equipped shops or manufacturing establishments; symbols indicating classification according to groups and sections within groups; where they are to be reviewed; parts to be carried by line personnel and ordnance maintenance companies, the latter with weights; and all other necessary and pertinent data in the form of notes attached thereto. They are now distributed to all branches of the service, whether in this country, insular and foreign possessions, or foreign countries. The demand for them is ever increasing.

Technical regulations, as the name implies, cover the instructions for the handling, repair, replacement, maintenance and upkeep of ordnance material, the application of the pieces, parts, assemblies, etc., as well as the removal of old pieces and preparation for repair together with the proper lubricants, greases, oils, etc., and their application.

The weights and volume data involve the study and compilation of such essential data, weights, volume, dimensions, methods of packing, crating, loading and shipping, etc., necessary in the determination of storage space and shipping requirements for use in war planning and other Ordnance Department activities, as well as the determination and assignment of proper freight classifications.

The administration of the Field Service Division is carried on through the chief of division under supervision of the assistant commandant of the school.

Low Pay of Army and Navy Officers

SUPPOSE our Army officers staged a walkout? That thought occurs to the *Minneapolis Tribune* in discussing the current movement to increase the pay of Army and Navy officers. "Of course, the Army never walks out on the Country, or considers such a thing," says *The Tribune*. "Yet the list of resignations shows there is something like a walkout in the Army." And the reason, we are told, is that many officers "have difficulty in meeting not only the standards expected of them, but of providing the merest necessities for themselves and their families."

The financial problem confronting Army officers is explained by the *St. Paul Dispatch*.

"On coming out of West Point, and receiving his commission, the new second lieutenant receives $1,700 a year pay, out of which he must buy uniforms and equipment of all kinds to accompany his rank.

"He gets free whatever kind of housing the Army post affords, varying from bare walls to fair comforts, but he must feed, clothe, and equip himself. Gradually, and with disheartening slowness, he advances to first lieutenant at $2,000 a year minimum, and after ten years or more becomes a captain with pay from $2,400 to $3,300 a year.

"If he has luck enough to become a colonel before retirement for age, his pay ranges from $4,000 to $5,000."

"The second lieutenant with a West Point education starts with only twelve dollars a month more than the newest policeman in St. Paul," *The Dispatch* points out. And although "it is well known that educators and teachers are considered underpaid, high-school principals in New York City are paid higher than brigadier-generals in the Regular Army," and "high-school supervisors in St. Paul get more than Army majors." Along the same line, the *New York Herald-Tribune* says:

"If Army and Navy pay is compared with pay received in other walks of life, it is evident that the present scale is not only inadequate and inefficient, but also unjust.

"The pay board has recommended increases of 60 per cent. Congress should act favorably on that recommendation. Officers of the Army and Navy are no longer being paid either commensurately with their responsibilities or in sufficient amount to afford them a reasonable livelihood."—*The Literary Digest.*

The Mutuality of Obligation

The Future of Our Industrial Preparedness Policies

By "Ex-Reservist"

ONE of the comforting signs of the times and an indication of our complete relaxation in this era of peace is the after-dinner habit of discussing and dwelling on a phrase. Stanley Baldwin may not have coined "the inevitability of gradualness," but as Prime Minister he built about it a strong appeal to his opponents for his conservative policies, openly holding out to them the prospect that gradually but inevitably they were coming into their own. Now Sidney Webb of the Labor government has built around it his own defense of his Labor government's policies "for socialism in our own time." It is pleasant to feel that we now have time to look around us, backwards into the past, the other way into the future, and about us at our own times and in the faces of our contemporaries, without the pressure of instant decision upon us or the fate of tomorrow hanging on the clarity and wisdom of our mental processes. And so I offer the phrase "mutuality of obligation," almost as awkward as Stanley Baldwin's in its syllabication, as the text of this discussion having in mind its especial bearing upon the future of the Army Ordnance Association and the policies to which it stands committed.

This issue of ARMY ORDNANCE marks its tenth anniversary. It is the sixty-first number issued—a good place to review the last decade, to take stock of its present assets and predict its future course. And you will doubtless find elsewhere within the covers of this issue such careful evaluations. The statement of the Association's policy on the title page of each issue defines the major obligations: first, the obligation this group of American citizens assumed to industrial preparedness, establishing the Association as a pledge thereof; then the several objectives assumed by the Association all clearly and carefully stated. Their mutuality is quite definite. Many other secondary objectives come to mind, secondary in that they derive from these major issues, but of themselves are of vital importance and great dimension. To several of these, coming as they do within the purview of a field agent, I will refer later. Logically, then, the future operations of the Association are largely concerned with the discharge of these mutual obligations, and it is well to inquire into them, consider their circumstances, into what fields of activity (industrial, social and governmental) they may lead, and what difficulties in the way of orderly progress are to be met. Here we confront the need for accurate forecasting of future events and who among us can play the role of prophet?

TURNING back to our title page and reading it again we see for one thing that effective publicity is the vehicle depended upon to "keep alive an interest in and knowledge of * * * munitions," * * * "to disseminate information on the progress of our munitions development" and "to keep available the highly specialized knowledge necessary for arming the manhood of the nation." This leads to a consideration of what effective publicity is now and what it will be five, ten, or twenty years hence. It may be defined here as conveying useful information to a receptive audience. This involves the factors of *form* and *substance* of the information (of which more later) and the *receptivity and availability* of the audience.

It is a current argument that the mass production of printed matter, the ease and facility with which billions of words may be placed before millions of eyes, makes for a general increase in knowledge, a gradual raising of intelligence levels and therefore increases the receptivity and availability of the audience. Possibly the contrary is the case. Many inferior intellects are getting a surface veneer of ill digested information, since the corner news stand, electric light and steam heat make reading easy for the multitudes. Many of this horde of low I.Qs. are thus stimulated to self-expression and their muddled inaccuracies are poured back through the printing presses for further confusion of their fellows. Ex-garage attendants write about economic conditions in Europe, ex-coal dealers publish many volumes of history, ex-convicts air their views on sociology, and so on down the list. And to this confusion the thundering herds of the radio, the moving picture, and now the sound film are adding their incessant clamor. Far from raising the real level of general knowledge, we are in danger of being smothered under confused waves of misinformation and prejudice. What the founders of the Association ten years ago conceived to be an adequate and dignified publicity vehicle for their purposes may be, ten years hence, and possibly much sooner, as ridiculously inadequate as the town crier's bell.

Now, as to the *form* and *substance* of *publicity*, I think we may safely predict that in "keeping available highly specialized knowledge" and to "effect coöperation with American scientists, inventors and manufacturers" the current form of essay and text book presentation of our subject matter will continue in conventional form. But to diffuse widely an idea, or an ideal, we are bound to employ the most efficient current methods, and today this means the radio, the moving picture, the special articles of the million a week magazines, and their advertising pages. Here we are led directly into the realm of propaganda and national advertising whose effectiveness we cannot question. When the first American troops paraded in the streets of London in 1917, it was not their youth, their freshness or their military appearance that drew the comments of the curbstone crowds. It was their open-mouth grins and the unbroken rows of gleaming teeth. The American dental profession quotes this as an example of medical or dental progress. In reality, the London girls were paying an unconscious tribute to American toothbrush and tooth paste manufacturers who for twenty years had spent huge sums for advertising (and had charged us thirty-five cents for a few cents worth of pasty soap.) Tom Paine changed the governments of the world with pamphlets obscurely printed in small editions. Today we must compete with tooth paste and silk stockings for public attention!

If the argument is reasonably correct up to this point, it leaves a pretty bundle of publicity problems on the Association's doorstep. But we are examining the obligations of the Association as set forth in its title page creed. And the first bold-faced sub-line at the top of the page reads "Pledged to * * * industrial preparedness * * * as * * * the strongest guarantee of peace." This is repeated in the first paragraph, and again in the summary of the objectives of the Association in the last paragraph on the title page. The triple repetition of the thought was not accidental. The founders of the Association had uppermost in their minds a strong desire for peace—and their purpose was to guarantee it. Therefore any line of action, every tangent of activity, must be scrutinized to see that, in itself, it strengthens this major guarantee. There has been much discussion as to the cause of war. It is a "state of mind," an emotion arising from a national consciousness, according to many earnest people who desire, as we all do, permanent peace. The followers of this school of thought decry all talk of war, all warlike panoply and activity. Too often they oppose all kinds of preparedness because of its effect on the national state of mind. Some of us recognize in this group the most sincere and intelligent opposition to our efforts. The corollary is obvious: if the Association can accomplish its mission in "effecting industrial preparedness," without stimulating the growth of national "war mindedness" this is the best course of action. Perhaps it will not be necessary to compete with tooth paste and silk stockings, after all. So I draw no conclusion here, but leave it, as an obligation, on your doorstep.

WE do not have to pursue this line of thought very far to see that we are sadly in need of a crystal ball to read the future if we are to discharge our mutual obligations. The leading role calls for a prophet, and accurate prophecy becomes increasingly difficult. Looking backward for a moment, and reconstructing our military situation of say—1910, it is trite to observe that a suggestion to make a war plan on the basis of supporting an expeditionary force of two million men three thousand miles overseas would have met with exactly the same reaction that today we accord a Sunday supplement smudge about a war with the Martians. To have pressed for its serious consideration at our war colleges or in the committee rooms on Capitol Hill, would have brought a quick counter prophecy involving indefinite residence for its proponent in the old red brick buildings of St. Elizabeth's. Admiral Mahan is perhaps the best example of an accurate professional forecaster. Writing forty years ago, the events of the last twenty years have demonstrated the soundness of his professional views. Although he addressed himself to a professional, and therefore limited, group of readers, there is no doubt that his ideas eventually permeated much of the more popular discussions of sea power in the intervening decades, and he is still quoted as the great authority. But apparently the inspired prophets of the nineteenth century turned to fiction and the short story as the best matrix for their visions. A composite version of fairly equal parts of Jules Verne, H. G. Wells, and Kipling makes a marvelously accurate forecast of World War developments—a full generation before the event, covering the fields of mechanical and chemical technology as well as military. Does this mean that we are to look to the mid-century writer of fiction for a preview of the next war? And will we recognize him when he appears? These questions apply to both matters of publicity and propheey.

Among the tasks of the prophet is the recognition of individual genius in science and leadership. Unfortunately, genius is too often lost to the world unless coupled in the individual with great energy and ambition. The importance of raising up genius to lead us depends upon how completely we accept the "great man" theory of history. This requires a little elaboration. There are at least three recognizable theories of the underlying causes of the development of civilization. The "great man" theory identifies with each period of maximum evolution a great mind as the originator and leader of the change. This is the Alexander—Cæsar—Napoleon—Saga, and ascribes our progress to a few minds—our civilization of today came from "a bucketful of brains." The next is the racial theory, tracing our history as the record of the origin, ascendency, conflicts and decay of the several racial stocks, determined by their relative inherent characteristics. Here we encounter a mysterious terminology; dolicho- and brachy-cephalics, the Alpine, the Nordic, and the Mediterranean. Its exponents have manipulated it largely to the glorification of the blue-eyed dolicho-cephalic Nordic blonde. The current growth of nationalism as a substitute for tribal taboos and religion derives much nutriment from these conceptions of causes. A third is the economic theory, which writes its records in terms of trade rivalries, market outlets, control of raw materials, trusts, taxes and tariffs. This is obviously the controlling concept in the minds of those in charge of our political and industrial fortunes today. The emergence of the economic theory and the ascendancy of organization control of affairs is quite marked. An interesting variation of the economic theory is the interpretation of its record in terms of metallurgy; ounces of gold, pounds of copper, tons of iron ore and ceramic materials. All events of history flow from their location, the struggle for their possession and exploitation. (I omit the oldest theory—history as revealed religion—a record of the blessings and punishments meted to mankind by a divine and inscrutable Providence.)

THE racial and the economic concepts are colored by fatalism. Their biological or mechanistic forces are beyond our control although they propel us in directions and at rates that we feel are fairly determinate. The individual plays a secondary part. Whether we subscribe to the "great man" theory or not—we need leaders, and we are continually drawing their numbers out of the hat. The decade since the war has adjusted our perspective upon its leadership. It produced no great men. They were all the logical products of their respective professions and environments—organization men, organizationally trained, and the organization could and did replace them as required.

But what we need in our present preoccupation is the occasional and exceptional leader—like Eliot of Harvard, who was made president of the university at the age of 35. He was an instructor in chemistry at the newly formed Massachusetts Institute of Technology when the call came to him. He knew "little Latin and less Greek." But he

asserted his authority at once and with a vigor which was unabated for forty years or more. He not only reformed education at Harvard, but throughout America. The world owes much to Charles William Eliot, but what of the man who made him President of Harvard? Whose was the prescience, in that little group of seven men called the Corporation, "The President and Fellows of Harvard University," which singled out this unknown chemist without any record of accomplishment, discerned in him the profound judgment and administrative ability, presented his name for a post hitherto occupied only by clergymen and scholars, and "sold" him to the six other Fellows? But for that prophetic vision America, and the world for that matter, might still be plodding along with the notion that higher education was intended solely for the so-called learned professions and was of no value to men in practical affairs. This is an example of the kind of selection or appointment that smooths the way for a generation. High dividends will reward successful prophecy in this selection of personnel. Whatever fortune may attend our selections of individuals and groups, it does not entirely dispose of the problems of our mutual obligations and I here must indulge in a mild criticism. I note in the literature of industrial preparedness, in the orders covering reserve officer duty and instruction and in the various texts and courses, an undercurrent or tendency to impose as light a burden as possible upon the "busy executive" or the "busy reserve officer." This has taken the form of protest against the increasing restrictions upon appointment and promotion of reserve officers, and the recently adopted policy that the Ordnance Department is to prepare its own factory plans and data is an expression of the same opinion. Now I differ from that conclusion. To hold the people we want we must challenge their attention and arouse their interest. There is no known way of doing this better than to give them a sense of ownership or participation in the enterprise, making them create it themselves. The essential ingredient here is that the tasks assigned be worthwhile and productive of permanent results. There must be no backing and filling. Dostoevski says (in "The House of the Dead") "If it were desired to reduce a man to nothing, to punish him atrociously, it would be necessary only to give his work a character of complete uselessness. * * * Let him be constrained to pour water from one vessel into another, or to carry earth from one place to another and back again, then I am persuaded that at the end of a few days the prisoner would strangle himself or commit a thousand crimes punishable with death rather than live in such an abject condition and endure such torments." Our obligation here is to guarantee reasonable value and permanency to the tasks assigned.

As I look over the various reports, schedules of production, sub-procurement schedules, reserve officer records, factory plans and their supporting data that have been built up—and I hope they are going a long way towards insuring the stability of the effort—as the machinery of decentralized manufacturing operations, I observe that they are, in the light of this discussion, a series of obligations placed by the department upon various individuals. Indeed the current efficiency of a field unit seems to be measured by its ability to pin these goat feathers upon selected representatives in their areas. Little recognition is accorded the other side of the relationship thus set up, the mutuality of these obligations that the field units of the Ordnance, the Department itself, and the Army Ordnance Association are underwriting in these transactions. Consideration of some of these obligations local to a district may illustrate this and support my text by special case.

IN assembling the mosaic of any production plan I have been impressed with the fact that, both in line and color, it is largely the expression of opinion. Euphemistically, it is "based upon the best information available, believed to be reliable but not guaranteed." The planning agent desires the truth or at least a prediction of future events in proper focus, so he must gather information from many sources. The attempt to plot the resulting curve involves the reconciliation of widely diverging views. When one expert says three months, and another one ten, and a third twenty, we are hardly justified in striking an average and saying that it will take eleven months to do a certain important thing. And yet such conflict of opinion is quite commonly encountered. The evaluation of collected data becomes a serious matter. A man weighs his statements most carefully and forces himself to call upon his best resources of knowledge and experience when he is staking money on them, as every contractor does in submitting a bid. Freed from that pressure, his imagination is given more play and he allows his wish to father his thought. To what extent our production plans are thus falsely illuminated by light of hope is an interesting speculation. In any event, the reasonable evaluation of these data is a definite obligation to the producing community.

THE question of adequate compensation to avoid confiscation of capital becomes acute when the objective is the so-called "early" production from existing facilities. When we work up a project which makes an important demand upon productive capacity we are concerned with compensating the manufacturer for the loss of his ordinary output, or else we in effect confiscate his plant. This becomes especially aggravated where we do not use the entire capacity of the plant, but must have the full capacity of one department, and where the loss of the output of this department stops the production of the finished article and in effect shuts down the entire plant. This is illustrated well in the case of the screw machine capacity required for metal components of the fuze, where the screw machine department of a plant can get into production very rapidly on fuze parts. This plant may manufacture electric novelties, bakelite products used as automobile engine auxiliaries, etc., and if we take over the screw machine department we shut down the entire plant although we have no use for any of the rest of it. The total cost of the finished product is many times that of the screw machine parts entering into its assembly so that the cost to the company per fuze part furnished would be many times any reasonable cost per part that the department ordinarily would have to pay. Under these circumstances we are exceedingly reluctant to force any arrangement on the basis of a reasonable cost per unit of production. There is no provision in law that would warrant us in giving firm assurance that the manufacturer would be compensated for the loss he would suffer in turning over his screw machine department to the muni-

tions program. What is our obligation here to the manufacturer?

There is no question but that some of the primary laws of physics apply to the conversion of manufacturing facilities. There is a distinct relationship between the mass of the plant, its inertia, and the time and force required to accelerate, and change the direction of, its output. The smaller the plant the easier it is to convert and the quicker it can reach its maximum production of a new article. This opinion is so widely entertained that it seems very natural to turn to smaller facilities in an effort to solve the problem of early production. The temptation is to collect a lot of estimates from small plants and assume that they represent in the aggregate a flow of production of uniform parts that would meet Ordnance Department inspection. Aside from the obvious technological difficulties, we at once run into the problem of overhead organization. The industrial preparedness plans of the department have been based since the war upon the principle of centralized control and decentralized operation and there seems to be a general agreement that these plans must be shaped to avoid a repetition of what happened in the early days of the World War. Logically the same principle must be applied in the district and the effort of the district chief must be directed towards decentralized operation so far as possible. In other words, he must select the fewest number of responsible contractors that the variety and quantity of his production schedule items will permit and turn over to them as completely as possible their responsibility for production. The direct employment of many small plants is a violation of this principle. The district chief has no organization at his disposal on M-day and must build up his organization after war starts and will at no time in the early days be in a position to meet the demand upon him. None of our plans are likely to build up any peace-time organization that can be other than the nucleus of key men and head men for the various activities. Under them must be trained a great body largely of civilian employees and any effort to expedite production by multiplying the number of plants multiplies in a much greater ratio the problems of district operation. It takes time to make such an organization and the time saved in actual machine hours is more than likely to be lost elsewhere higher up.

Another point that must not be lost sight of in the use of smaller plants is their relation to the larger plants. This argument runs about as follows. The larger plants have the management, organization, capital and equipment that insure a satisfactory product. Better and more satisfactory results will be obtained by making available for the larger plants the skilled workmen and machine tools in the immediate vicinity as fast as they need them and this can well be done by shutting down smaller plants, buying them up lock, stock and barrel if need be. This describes an extreme situation. Without going to that extreme there is no question but that the larger plant can expedite production by intelligent sub-contracting among smaller plants or shops in the same industrial area. This is a customary peace-time method and the set-up in the plant through its purchasing department is calculated to get quicker and better results from a smaller contractor than the new and untried district organization which comes into the field as a stranger. Here the obligation is clearly to the industrial community. It must be offered a workable plan designed to let it contribute its best effort to the cause. It must not be harassed by impracticable proposals, the interrelationships of peace-time must be disturbed as slightly as may be, and so on.

IN trying to point out here the obligations resting upon the proponents of industrial preparedness I have been led to consider the trend of future events and to emphasize the need for accurate forecasting and it has been difficult, as all prophets have found, to retain an optimistic attitude. Nor does the occasion call for a Jeremiad. But I believe the conclusions afford, on the whole, some comfort and reassurance. It is pretty generally agreed that we have not yet reached the zenith of the industrial era, nor are we likely to until the earth's resources of metals and minerals are exhausted or unless the human machine breaks down. Whichever theory of civilization's evolution is correct, or if they are all partially so, we shall see an increasing use of machinery. The ratio of ton miles of freight moved, tons of installed machinery, of mechanical horsepower per unit of population is going to increase in peace or war. This means increased mechanization and a multiplication of all of those ratios in war time. The system we have discussed here (call it the District System, or Industrial Mobilization, or Ordnance Organization, as you please), as it applies narrowly to ordnance or broadly to all apparatus for war, has been skillfully worked out to face effectively in any direction from which the need may come. If the "great man" theory is correct, then its nation-wide organization with its contacts in the colleges, shops and offices can best discover genius—wherever it may be. If we need ordnance as we now vision it—certainly it will be forthcoming, but what is equally certain and of greater importance, is that this system can produce in great quantity whatever new and strange devices may be needed more quickly and more effectively than by any other scheme proposed. What such devices may be I leave to your imagination—death ray machines, interstellar flying robots, or transport vehicles suitable for the terrain of Mars for the supply of a Martian expeditionary force. The system seems simple and elastic, tenacious but not bulky. It is inconspicuous in peace but apparently substantial. It is this passing decade's provision against the emergency of the future.

The Army Ordnance Association Trophy Rifle to be Awarded the Winner of the President's Match, National Rifle Matches, Camp Perry, Ohio, August-September, 1930.

Modern Thought in Division Artillery

A Description of the Light Field Gun Carriage, T2

By Elmer C. Goebert*

AS nearly as can be determined the first mobile divisional gun carriage was conceived in the latter part of the 14th Century. It consisted of a gun carried in a wooden cradle which was mounted on a wooden axle with two wheels and the trail which extended to the rear. The recoil energy was dissipated by the entire rigid structure moving to the rear when the gun was fired. Since its inception step-by-step development brought it from the crude wooden structure to an efficient machine of metal, the fundamental characteristics, namely, the axle, the two wheels and the trail and the principle of firing on the axle supported above the ground on the wheels or some sort of footing and strutted to the ground by the trails, remained with the design. Not until 1929 was a real attempt made to produce a divisional carriage designed along principles distinctly different from the old conventions.

Fig. 1. 75-mm. Gun Carriage, T-2. Emplaced for 360° Traverse; Fired at 80° Elevation; Gun is in Full Recoil.

In years gone by the artillery mission of the divisional carriage demanded fire on fixed or slow-moving ground targets and for such purposes the limits of traverse and elevation inherent in the so-called conventional type gun carriage were acceptable. It was probably on account of this fact that no real effort was made to produce a carriage designed along new principles. With the introduction of the airplane, dirigible, and tank during the World War and the post-war development of efficient, high-speed armored cars, tractors and wheeled prime movers the mission of the divisional gun apparently changed. The terrestrial problems no longer are fixed and slow-moving targets allowing ample time to slowly elevate and traverse the carriage, but now include fast-moving targets for which some of the more optimistic conceive speed of fifty to sixty miles per hour. The effect of this added problem is to increase the required amount of traverse so that the old conventional principles of design are no longer applicable.

THE effect of the air targets upon the divisional carriage has resulted, as is true in most all new problems, in two schools of thought. An attempt will be made to outline both views and at the same time give the effect of each upon the designers' problem.

The one school holds that in addition to the terrestrial problems it will be the mission of the divisional carriage to engage air targets in its sector for its own as well as the protection of the troops which it is supporting and, therefore, the divisional carriage, in addition to the characteristics needed for terrestrial work, should include all features necessary to make them formidable antiaircraft weapons.

A weapon to meet these demands embodies many complications. First of all, it requires a high muzzle velocity gun to be effective with an angle of elevation of at least 80° and a full 360° traverse. The traverse is readily obtainable at the cost of added weight by using additional outriggers. To obtain the elevation, however, means that the gun must be trunnioned as far to the rear as possible and overhung in the trunnion arms far to the rear of the center of rotation of the top carriage. The result is a high force due to the high velocity gun with the load applied in such a manner as to demand massive construction in the top carriage with its resultant added weight. Again, variable recoil must be provided to maintain stability at low angles of elevation which in turn means added complications in design.

The second school holds that the divisional carriage should not be looked to for protection of itself or any other elements of the combat troops in the event of air attack; that the protection of the troops should be left to a highly trained and developed special antiaireraft unit and that, in addition, for its own defense in necessity each battery of field artillery should be provided with a number of machine guns of sufficient caliber to provide reasonable protection.

These requirements as far as they effect the design of the divisional carriage can be met readily and, in fact, are met in the 75-mm. gun and carriage MI.

Which of the two thoughts expressed above is correct? Time and study and perhaps experience only will tell.

THAT this problem was given consideration at the close of the World War is evidenced in the report of the Caliber Board (Westervelt Board) published May 5, 1919, from which, under the title "Types of Artillery Recommended" and caption "Light Field Artillery" is quoted:

*Chief, Mobile Carriage Section, Artillery Division, Office of the Chief of Ordnance, Washington, D. C. Captain, Ordnance Department, U. S. Army.

Fig. 2. 75-mm. Gun Carriage, T2, Traveling Position, Left View.

"Gun, Ideal. A gun of about 3-inch caliber on a carriage permitting a vertical arc of fire of from minus 5 degrees to plus 80 degrees and a horizontal arc of fire of 360 degrees, etc."

At the time this recommendation was made the problem was considered impossible of solution since the design was limited by reason that it was believed the divisional carriage must be horse-drawn. Also at that time carriages had to be constructed of castings, forgings and riveted structures which all made for excessive weights for horsedraft carriages with the characteristics specified.

With the development and refinement of such important elements as commercial six-wheel trucks, alloy steels and the art of welding came the possibility of a reasonable solution of the problem.

It has become evident that the horse can be replaced by efficient motor vehicles so that close limitation of weight no longer is a controlling factor and that the generous use of welded structures makes possible the construction of carriages of reasonable weight that will withstand the added structural loads.

The importance of carriages to withstand road speeds of 25 to 35 miles per hour to permit rapid movement of artillery positions has come to be recognized. The almost universal development of good roads all over the United States has made this factor of great importance. Tests have been made which conclusively determined that the carriages used in the past would not withstand the strain of this travel over the road due to their more or less rigid construction.

In August, 1928, the first studies of a high speed divisional carriage were undertaken and in November, 1928,

Fig. 3. The T2 Mount in Traveling Position, Front View.

Fig. 4. 75-mm. Gun Carriage, T2, Traveling Position, Right View.

studies of a four-wheel, pneumatic-tired trailer mount were completed. The carriage had an elevation of 45°, traverse of 180° and the estimated weight was 8,000 pounds. The advantages of the design were not considered sufficient to warrant constructing a pilot mount.

In May, 1929, the study of an all-round fire 75-mm. high-speed divisional carriage was undertaken in the Office of the Chief of Ordnance. Simultaneously a study was directed to be made at the Watertown Arsenal. The Watertown Arsenal design resulted in the construction of the 75-mm. Gun Mount T3 which was described in the article "A New Weapon for Field Artillery" by Maj. G. M. Barnes, Ord. Dept., which appeared in the May-June, 1930, issue of ARMY ORDNANCE.

In this article an attempt will be made to describe clearly the 75-mm. Gun Mount T2 which resulted from the Ordnance Office study of the problem and point out the principal points wherein the two mounts differ.

SIMPLICITY, low cost of production and ease of operation were the watch words of the T2 design. A study of Figs. 2 and 4 will illustrate the simplicity of the carriage.

It consists of a cylindrical pedestal as illustrated in Figs. 3 and 5. The axle passes through the center of this pedestal and is strutted to it by two radius rods. A coil spring is interposed between the axle and top carriage bearing support. On the outside and paralleling the vertical axis of the pedestal cylinder are two lifting racks the bottoms of which are attached to a circular lifting plate. The lifting plate is housed inside the cylindrical spade under the pedestal plate. The racks are operated by a pinion shaft which passes through the pedestal cylinder

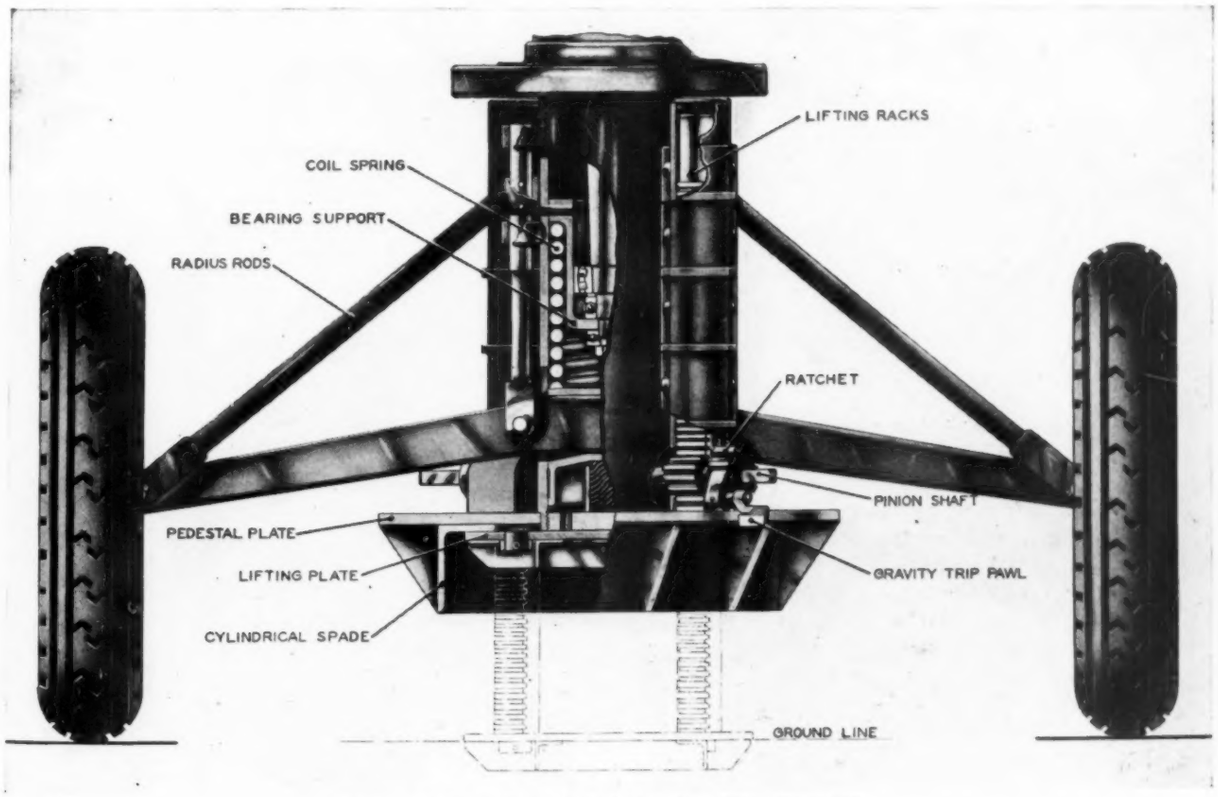


Fig. 5. Skeleton View of Pedestal Assembly, Mount T2.

Fig. 6. The T2 Mount Emplaced for Terrestrial Fire, 120° Maximum Traverse.

under the axle. The ends of this shaft are squared to take two 36-inch ratchet wrenches. On one end of the shaft proper is a ratchet equipped with a gravity trip pawl. The traversing worm wheel is attached to the top of the cylindrical pedestal. The three outrigger supports complete the pedestal construction.

The top carriage is of welded steel construction formed from three nickel steel plates with the pintle press fitted and welded into the structure. The traversing handwheel and worm is attached to the top carriage as is the elevating handwheel and gear mechanism.

The outriggers are of structural nickel steel and are approximately 15 feet long. Two of the outriggers are permanently hinged by pin joints to the cylindrical pedestal. The third outrigger is removable and in transportation is carried as shown in Fig. 7.

The wheel equipment consists of two quickly demountable wheels carrying single 34 x 7 heavy-duty truck tires with puncture-proof inner tubes. The trunnions, top carriage pintle and axle bearings are equipped with high grade antifriction roller bearings.

Fig. 7. T2 Mount in Traveling Position, Rear View.

The problem of emplacing the carriage is extremely simple. It requires, however, that the gun position selected be fairly level, which may be said to apply to any type of carriage where the bottom carriage is placed on the ground for support in the firing position.

The carriage is rolled into position on its wheels, the loose outrigger removed from its traveling position and the two hinged outriggers spread to approximately 120°. The lifting plate previously described is dropped to the ground by tripping the gravity pawl and the carriage then raised by the ratchet wrenches until the wheels are free from the ground. The ratchet wrenches are then removed and the wheels taken off. The gravity pawl is then tripped which allows the entire carriage to drop, driving the cylindrical spade into the ground.

If the mission is against ground targets with a field of traverse limited to the spread of the outriggers, the third or loose outrigger need not be attached, since in this position the carriage has been proof-fired at 0° and is staple. For 360° traverse, however, the third outrigger must be put in place.

Fig. 6 shows the carriage emplaced for terrestrial targets with limited traverse while Fig. 9 shows it emplaced for full 360° traverse and use against ground or air targets.

In going from firing to traveling position the third or removable outrigger is removed, the carriage raised, the wheels replaced, outriggers closed and lifting plate raised in traveling position, and third outrigger loaded when the unit is ready to limber to its prime mover. It is believed that as designed the weapon can be readily handled with the normal gun crew of eight men.

The following statistical table should prove of interest as

Fig. 8. The T2 Mount in Firing Position, Rear View.

a comparison between the T3 mount described in the May-June, 1930, issue of this Journal and the T2 mount described above.

	T2	T3
Weight of Gun with Breech Mechanism	1475-lbs.	1475-lbs.
Total Weight of Tipping Parts	1865-lbs.	1865-lbs.
*Weight of Gun and Carriage in Traveling Position	5900-lbs.	5813-lbs.
**Total Weight of Outriggers	1250-lbs.	1008-lbs.
Traverse	360°	360°
Elevation, Maximum	+80°	+80°
Traverse when emplaced for ground target only	120°	90°
***Crossleveling	none	+6° to -6°
Lunnette load	653-lbs.	543-lbs.
Weight of bogie	none	1659-lbs.
**Length of Outriggers	15′	14′-2″
**Total length overall	24′	23′-2″
Road clearance	9″	12″

*The pilot carriage T2 at the present time weighs 5900 lbs. in traveling position and 5520 lbs. in firing position, however recent firing tests have indicated that the total weight of this unit in traveling position can readily be reduced to 4900 lbs. and its stability still maintained. This is possible since all weight except that of the wheels remains with the carriage when in firing position.

The weight of the T3 carriage cannot be materially reduced since 1659 lbs., the weight of the bogie, is removed from the carriage when going into firing position for 360° traverse under which condition the weight remaining, 4154 lbs., is the minimum which can be used and still have the carriage stable at low angles of fire.

**Firing tests recently conducted indicate that the outriggers on the T2 carriage can be reduced to a length of 12 feet which will reduce the weight of the outriggers and the overall length correspondingly.

tials, the Sight Mount, M1 for the standard 75-mm. field matériel. The elevation unit is a slight modification of the Range Drum, M1 for the same matériel.

For firing on ground targets, the usual setting means are provided. The sight mount corrects for out-of-level in transverse direction, allows angle of site setting and setting for fore and aft out-of-level condition. The latest type of panoramic sight will be used. The range drum provides for the usual site settings, mils elevation setting and range elevation setting.

The above devices have been modified so as to adapt them to aerial fire. The sight mount corrects for out of level in the transverse direction, just as in ground fire, and indicates the amount of this correction. The correction is put into one side of a differential, the other side being actuated by the traversing mechanism of the carriage. The output of this differential is the present position of the gun in traverse, qualified by the correction for out-of-level. This output is visually indicated on one dial of a data receiver. The other dial, operated by the director, indicates the desired position in space. Matching these two pointers by traversing the gun, completes the setting.

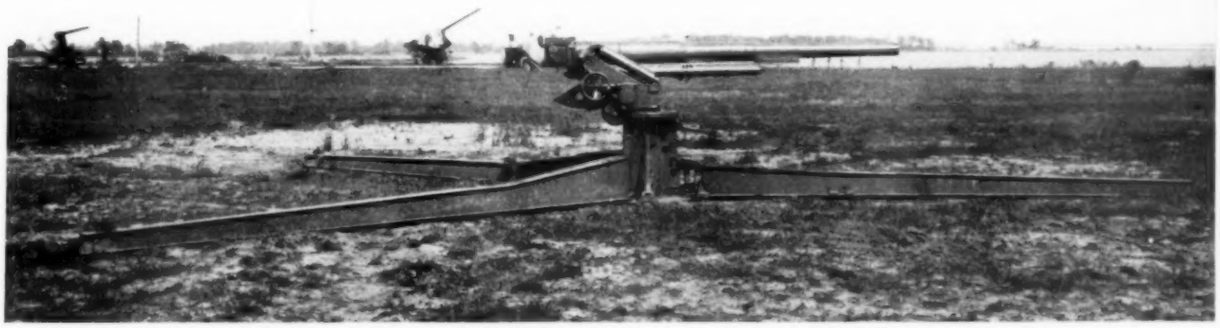


Fig. 9. 75-mm. Gun Carriage, T2, Emplaced for 360° Traverse, 0° to 80° Elevation.

***The T2 carriage has not been provided with cross-leveling since it is primarily a ground target weapon with possibility of operation against aerial targets when necessity arises. The gun carriage must be provided with a dual purpose sighting system combining the operating requirements of terrestrial fire with those of antiaircraft fire.

FOR use with the T2 mount a sighting system is now under development in which the combination of the two elements, namely terrestrial and antiaireraft fire, has been accomplished without in any way compromising either the use of the weapon as a field piece or for antiaireraft defense.

The entire burden of correcting the line of fire for errors due to the out-of-level condition of the mount is placed upon the sighting system. From an engineering point of view this system is more desirable and sound than is the system of crossleveling the top carriage; since in correcting the sight a smaller mass is moved than when the entire top carriage and the massive tipping parts are moved to establish them on a level plane. The crosslevel sight system has the further advantage that in operating the gun the gunner can control all laying without depending upon the other members of the gun crew to keep the mount level.

Description of the Sighting System. An azimuth unit is furnished on the left side of the carriage and an elevation unit on the right side. The azimuth unit is in essen-

The range elevation drum corrects for the error in the elevation direction due to the mount being out of level. The immediate mechanism accomplishing this correction consists of a bubble with paired index, reading against a family of curves of angular elevation. Each of these curves has been rectified by the amount of the correction referred to the indicated cross-level angles.

It is intended that two of the approved type of antiaireraft data receivers will be used with the system thus tying it in electrically with the director and height finder. A third data receiver will be required if it is intended to use the continuous fuze setter developed for antiaireraft.

In conclusion, it may be stated that the T2 mount can be adapted with slight modifications to any use outlined for the T3 mount and it is believed that it is simpler in construction with a resultant lower cost and ease of procurement in time of emergency which elements are of vital importance in the solution of the great problem of defense.

It has one feature namely the self-contained lifting mechanism which should make it superior to the T3 mount in the element of handling the carriage into firing position and from firing to traveling position and it is believed that with a trained gun crew it will require considerably less time for handling than is required for the T3 mount.

The Study of Business Problems

The Methods of Administration as Taught at Harvard University

By Georges F. Doriot*

I HAVE been asked to outline to you[1] a method of attack for the study of business problems. In your work on industrial mobilization, you should be able to follow main trends and happenings in the business world. Then you often have to make a rather close analysis of manufacturing companies and their problems in peace and in war. It is necessary for you in your work on procurement planning, when you go into a plant, to be able to speak the manufacturer's language and to grasp existing problems and those that would arise in the case of a major emergency. Your problem is further complicated by the fact that in case of war, time becomes of such great importance and problems to be solved are new and unexpected, usually needing immediate answers.

I do not expect to give you any method by which you might become effective and useful business men. There is quite a difference between the man who can analyze and study situations and the man able to carry out plans. In business, the first part of the job you can do. The second part you are not expected to do, but you should know enough to be able to select men, to know whether or not you can trust them, and also to measure their ability and the effectiveness of their results.

It would probably be useful for me to give you some idea as to the methods of the Graduate School of Business Administration at Harvard. Your problem is somewhat different from the one we have to meet in our school. We are taking young men out of college who have to go into business without ever having had much contact with men and actual problems. Naturally we have to give them a certain amount of knowledge, but beyond that our main endeavor is to train them to think clearly and logically and to help them through the transition state between college work and the work of business.

I shall outline in a general way the Business School's ideas on how to teach business, but while I do so, I hope that you will remember that you are not to compare your problems with those of our students. You are Army officers and as such you must be able to do at least two things. First, you must be able to make plans by which the Country's natural resources and productive forces can be coördinated to produce in the fastest time possible, and as close to the place required as feasible, the necessary supplies for civilian and Army use in time of war. Second, you must be well fitted to carry out operations in the field. The latter is, of course, your particular job and requires no comment from me; the former is, as you will notice from the words I have used, a work of planning and controlling which is highly essential.

So that you will not misunderstand the school's aims and come to the conclusion that we are training young men to expect to become executives upon leaving the school, I wish to state most emphatically that our men are made to realize that they should be willing to start as far down the scale as necessary when entering business. They are also made to recognize that the greatest thing the school can do for them is not to burden them with facts and figures, but to develop in them some realization as to the proper way of stating and analyzing problems. Contrary to legal or medical cases, the purpose of our study of cases in business is not to have a man leave the school remembering a certain number of accidents or methods suggested by a professor in any particular case. Those cases are nothing but tools which make necessary a certain amount of thinking based on stated premises if one is to arrive at a possible answer.

With us, cases do not establish precedents; they merely provide food for thought.

We are not teaching any sure way of making money quickly and we are not concerned particularly about answers to problems. We are interested, however, in helping a man pick out factors of main importance in a situation and, through clear-headed thinking, forcefulness and mental honesty, develop those factors up to the point where the answer comes naturally. We want not only thoughts but also logical sequence in their expression.

OUR object is to teach business. Therefore, I should like to state that in spite of many statements to the contrary, business can be taught. A discussion as to reasons why it can or cannot be taught is out of the scope of this paper. One point, however, which perhaps I may make, is that personally I do not necessarily regard business as a science. I look upon it much more as an art in the execution of which scientific knowledge and methods can and should be applied. There is no reason why a painter or an artist should not use the results of science, research and discovery. Any activity such as business, where the human element is an important factor and where premises are still poorly determined and rapidly changing, cannot be referred to as a science without incurring the danger of misconception by the average mind.

To teach business effectively, during the two years that we have at our disposal, we divide the field in a rather arbitrary fashion along lines which we might refer to as functional. In the first year, we have five courses, all of them compulsory: industrial management, finance, marketing, statistics and accounting. In industrial management, questions of organization, equipment, plant layout, buildings, location, manufacturing costs, controls, etc., are taken up. In finance, commercial banking, promotion, organization and reorganization, and administrative policies, as applied to individuals and corporations, are studied. The marketing course, also quite broad in scope, covers cases in retail and wholesale distribution of consumer and industrial goods, sales organization and promotion, advertising, price

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1. An address to the student officers, Army Industrial College, Washington, D. C.

policies, etc. Business statistics and accounting are courses covering those subjects which might be regarded as tools of control at the disposal of the executive.

In the second year courses we develop in greater detail topics of main importance taken up during the first year. For instance, in the field of finance, we offer a course in corporation finance, one in investment banking, and another in bank management. In marketing, there are courses in advertising, sales management, export sales management, retail store management, etc. Those courses are elective and inasmuch as they are more specialized, come closer to giving the student the actual knowledge he will need in the field into which he expects to go when leaving the school. This gives him some idea as to the type of problem that will confront him in the early period of his business life.

Having studied subjects of importance in management, finance, distribution, accounting and statistics, the students at the present time are required to take, in the second year, a course called business policy, where the different fields and activities enumerated above are brought together and coördinated. In my mind the problems taken up and the methods followed in this course are quite applicable to your own situation. One of the objects of the course is to prevent a man, to some extent, from becoming too specialized. We want our students, together with their particular capacity along certain lines, to have the imagination and ability necessary to analyze and grasp the component parts of important administrative problems, to follow scientific methods of reasoning, and to be able to decide where effort should be placed. We want them to learn how to make and to carry out plans.

IT is necessary for you to remember that one cannot get along any more in a business enterprise by merely knowing all the intricate details of one's own business. An executive at the present time must be able to follow trends and discoveries in other lines. Competition is no longer between individual companies within an industry but it is between industries also. It is often more necessary to know more about the other man's business than it is to know details about your own, which can be followed and checked up by a less experienced person. A man needs to be a coördinator, having the ability quickly to place his finger on the most sensitive points in a business situation. He is only entitled to be a critic when automatically in his mind the realization of the point to be criticized means a constructive idea. He must realize that there is nothing remaining unchanged, that premises and scientific facts vary and fluctuate. A business is not to be looked upon now as a tangible undertaking built upon solid and immovable foundations. The purpose is not to reach a point where the business is in perfect equilibrium. The goal is to realize the direction and strength of the fluctuating forces affecting you and to fit yourself into them, as under ordinary circumstances they cannot be modified.

You should have some idea as to what is meant by general business situations and conditions, and you should develop the ability to sense them, remembering that elaborate business statistics are little more than useful indications. Statistics can be compared to history or experience; they represent the past, never showing a complete and impartial picture of any current situation. It may be well, when listing factors to be considered in arriving at a decision, to study questions set forth by past statistics, but to my mind the final and determining factor should never be one based upon a reflection of the past. Experience is very useful, but sometimes a hindrance. It is safe to say that in business, things very seldom happen twice the same way, and that ideas rapidly become obsolete. Thinking too much of, and relying too much upon, experience will inevitably lead to mistakes.

Running a manufacturing concern does not mean that your job is to keep on manufacturing the product which has been manufactured in the past, in the very buildings and with the same equipment which has been handed over to you. It merely means that manufacturing activities will be selected by you with a view to making money and showing returns on an investment with which you have been entrusted. It should never be taken for granted that because one's predecessors decided to make a certain type of product in a particular building that the following generation should be proud of the fact that the same building is still used and the same product made. One must constantly challenge the usefulness of, and demand for, a product, as well as the particular methods used in manufacturing that product.

Business is always confronted by problems arising from the fact that raw materials are constantly fluctuating in price, quality and quantity; that new and improved manufacturing equipment is always being developed and that the demand for the finished product is constantly shifting.

Both manufacturing and distribution methods are constantly changing. For a great many years it was understood that the main problem in industry was to produce, and that whatever was made could be sold. At the present time, many claim that it is the other way around, that anything can be made and the main problem is how to sell it. Personally, I believe that neither attitude is correct. It is the proper coördination between the two, the proper realization of the fact that one cannot go without the other, which may lead one to some success.

I should like, therefore, to state that the first and probably the main thought you should consider is that one of movement and change. A business which, over a period of time, continues making and selling the same product by the same methods, runs into the danger of having a competitor develop a product which is higher in quality or lower in cost.

ANOTHER question which I might bring to your attention concerns the relationship now existing between banking and manufacturing. A banker should no longer be looked upon as an intermediary to whom one can go for cash when new equipment or additional raw materials are required. Because of the fact that few businesses are now privately owned, bankers have had to change and adapt their relationships to a changed situation in industry. No one sentence can be given that would characterize that new relationship. The size of the manufacturing company and its importance will determine the problems to be met in the raising of capital, the kind of banking firm that can handle the financing, and the type and quality of money available. One point to be remembered by manufacturers in this connection is that there is a quality to capital just as there is

to raw materials or equipment. The manufacturer who is received by a banking firm of high standing and reputation gets many intangible advantages as well as cash. Those intangibles are often worth a great deal more than the money itself, not only to the manufacturer but to the stockholder. Personally, I believe that for a long time to come the banking firms of highest repute, they who consider themselves not as mere intermediaries for manufacturers and stockholders but who realize their responsibilities as well, will naturally get the highest grade of manufacturing companies to finance. Such banking houses realize that at the present time money should not be loaned just on the basis of past operations or because certain arbitrary, and often meaningless, ratios meet expectations.

The present relationship between bankers and manufacturers brings up several dangers to be guarded against. Bankers have an excessive desire to merge or increase the size of manufacturing companies whether or not such actions are justifiable and they seem to believe that the larger a company is, the better off it will be. A banker will generally try to gauge the worthiness of a manufacturing company purely on an analysis of the past. Another fallacy, altogether too prevalent in banking circles, is the belief that several weak companies placed together will make a strong one. There have been many cases, also, where bankers have been unable to see that merging several companies doing well would undoubtedly mean a complete failure for each of the component parts.

Certain bankers have attempted to specialize in certain industries, thus becoming expert and reducing costs of investigation. This situation is dangerous because it leads the banker to believe himself able not only to advise but to manage. It has one advantage, however, in that small companies might be able to get money thereby from a fairly large bank, while without specialization the bank would not bother with such a small manufacturing unit. In the case of small companies a large bank is usually unwilling to become interested, due to the fact that the investigation is almost as expensive as it would be in the case of a large one; the amount of time to be spent by the bank and the responsibility involved is as great, while the sale of securities will net only a small return.

I SHOULD like to say a few words about the question of leadership. On this subject a great many books, words and statements have been wasted. I am not able to give a definition of a leader, and do not believe that a man can be trained to become a leader. Men are natural-born leaders or they are not. Our job is one of selecting leaders, perhaps developing them, but certainly not of making them. The best organization is one where a man is actual head, and where the organization is not so large that contacts with subordinates are purely through statistical evidence. It takes too long for the head of a large organization to know what has happened and too much money is expended on the paper work necessary for giving orders and checking them up.

When looking at most textbooks on industrial management, one comes to the conclusion that there must be a certain number of systems or schemes, a close adherence to which is bound to mean success in manufacturing. Unfortunately, application of these systems does not make for success in manufacturing, inasmuch as they prevent a close analysis of manufacturing problems. Also one is apt, when reading current literature on management, to arrive at strange and fallacious conclusions with reference to size of business units. There is no such thing, in a highly industrialized community, as an ideal size for a manufacturing unit. There may be several sizes where the business is able to operate economically. Changing forces outside the business, which are generally uncontrollable, necessitate continual readjustment of the manufacturing unit.

It might be advisable to look at manufacturing problems with these factors uppermost in one's mind: cost, volume and quality. The natural and desirable tendency at the present time is to decrease costs of production, which step requires a criticism of the company's present aims, and the methods now utilized to accomplish those aims. It also requires formulation of constructive policies with respect to many things such as cost of capital, taxes, reserves, standardization, simplification, methods of wage payment, research, substitution, purchase of equipment, manufacture versus outside purchase of parts, mergers, volume of production, and quality of product.

It must be remembered that a manufacturing unit should, above all things, be flexible, readily adjustable to quantitative or qualitative changes in demand, and that there is no justification for carrying on a manufacturing operation on any product or part of a product, unless an adequate return upon the investment is being earned.

I should like, were it possible here to go into all of these problems with you more thoroughly, and to discuss other problems which are perhaps equally significant, such as methods of measuring and protecting yourself against competition, questions of regulation and government interference, tariff, railroad rate structure, patents, reorganizations, etc.

My aim has been to outline or suggest a method of attack, to present a point of view or a frame of mind. No system of any sort will ever take the place of clear thinking and common sense. Business problems should be attacked with complete mental honesty, with a fresh point of view, and without prejudice or predetermined ideas. Otherwise false conclusions are bound to follow.

Tractor-Tanks Tested

INTENSIVE study and experiment have been in progress by the Tank Board during the past six months to determine the practicability of converting commercial tractors into tanks for emergency purposes. The recent practical tests conducted have brought forth the conclusion that there is no commercial tractor at present on the market which has suitable characteristics for conversion into a tank without very extensive modifications. The resultant vehicle would even then be make-shift.

The obvious advantages of being able to convert the commercial tractor, which is in large production, into a tank during an emergency, made it desirable to investigate fully this possibility.

Although it was decided that no present commercial tractor was adapted for conversion into tanks, the project, because of its importance, will be a continuing one, and if later a tractor with more favorable characteristics should be produced, further tests will ensue.

Searchlights and Sound Locators

Part III: The Comparator, Power Unit and Sound Locator

By R. E. Gillmor and P. R. Bassett*

IN the complete antiaircraft searchlight system the elevation and azimuth of the approaching aircraft are determined by a sound locator which will be described later. Coördination of searchlight and sound locator is obtained by means of the comparator shown in Fig. 1. This instrument is mounted on the controller and becomes a part of it so that its dials are continually before the operator who controls the searchlight. It will be observed that the dials indicate and compare the angular position of searchlight and sound locator in both azimuth and elevation. The small dial marked "Tripod" shows the relation of the controller to the base line between searchlight and sound locator.

Fig. 1. The Comparator Shown Here is Mounted on the Controller

It enables the searchlight operator accurately to coördinate the searchlight with the sound locator. Both controller and comparator rotate to follow the searchlight in azimuth.

The four large dials of the comparator are driven by alternating current synchronous motors which are electrically connected to transmitters on the searchlight and sound locator. The transmitting generator and receiving motor are identical, both mechanically and electrically. The fields of both are connected to a common source of alternating current. The three-phase rotor windings are connected to each other as shown in Fig. 2. When the transmitter rotor is turned, currents are generated which cause the receiving motor to rotate to a position such that a counter electro-motive force will be generated which will be exactly equal and opposite to that generated in the transmitter. This will not occur until the receiving rotor occupies the same angular relation to its field (stator) as that of the transmitter rotor. The receiving motor thus follows all movements of the transmitter.

The transmitters are so geared to their respective units that they make only one revolution for each revolution of the searchlight or sound locator as the case may be. The system thus has the advantage of being completely self-synchronous, that is to say, the dials will jump at once to the correct indications as soon as connections are completed and current is turned on and will thereafter follow the transmitters with perfect synchronism. This is a great advantage in a mobile system where saving of time in making ready for action is sometimes of the greatest importance.

The operative relations of the distant electrical control, the comparator, the searchlight and the sound locator are shown diagrammatically in Fig. 3. Direct current for the searchlight and controller and alternating current for the comparator are produced by the power unit which will now be described.

THE power unit serves several purposes; it carries the searchlight, the controller, comparator, cable reels and other accessories; it tows the sound locator and it provides direct and alternating current for the operation of the searchlight, the distant control and the comparator.

The requirements which the power unit must meet are: (1) absolute dependability under all conditions likely to be encountered in service, (2) convenient, rapid and secure stowage of searchlight and accessories, (3) ability to traverse any terrain capable of supporting the wheels and to climb any gradient on which wheels can gain traction, (4) ability to maintain a speed of forty miles an hour on a level road, (5) ability to generate fifteen kilowatts of power for periods exceeding ten hours without overheating, (6) automatically maintain a nearly constant speed of generator when current is thrown on and off the searchlight arc, and (7) be sufficiently quiet in operation to avoid interference with sound locator at a distance of 1000 feet (303 meters).

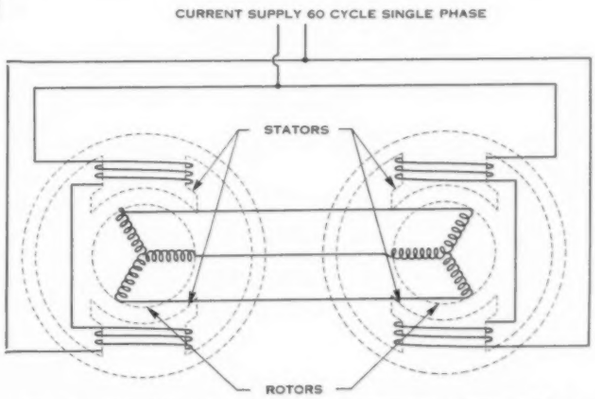

Fig. 2. Principle of A. C. Self-synchronous Transmission Employed in the Comparator.

In arriving at a completely satisfactory means for meeting all these requirements, the Sperry Gyroscope Company, in coöperation with the military services, devoted several years to the study of numerous designs and to field tests of

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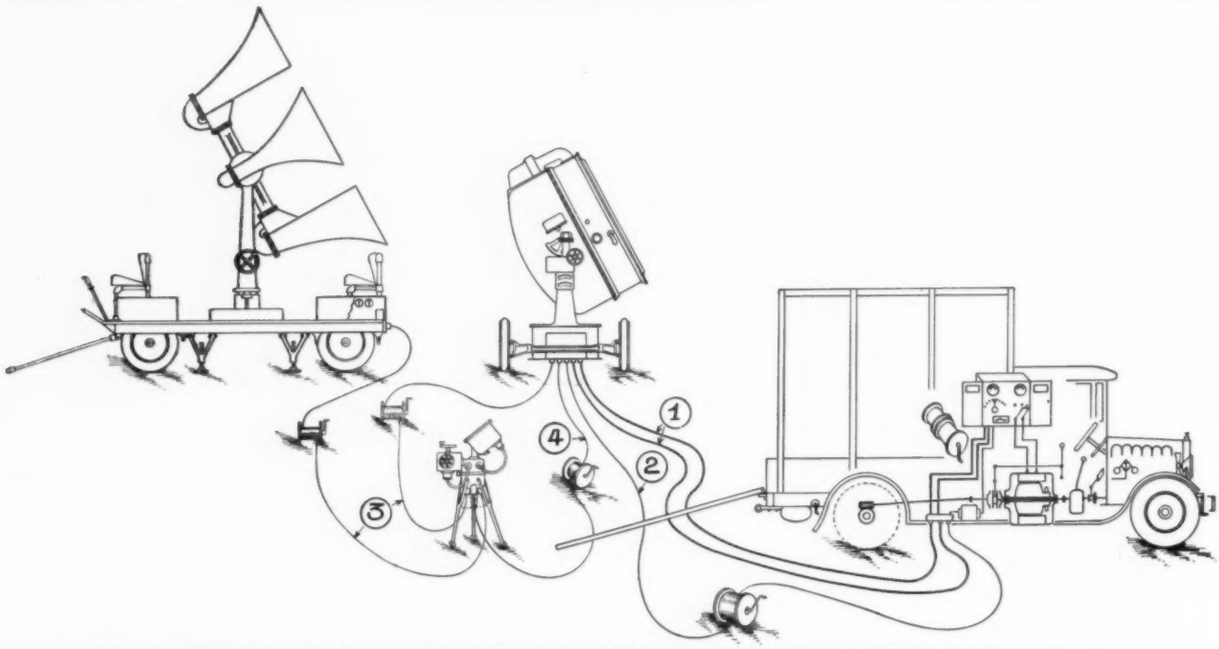

Fig. 3. Operative Relation of Distant Electrical Controller, Comparator, Searchlight and Sound Locator.

When properly disposed in the field, the power unit is 600-feet to one side of the searchlight, the sound locator 400-feet to the other side and the controller half way between the searchlight and sound locator. 1—Power cable from power unit to searchlight. 2—A. C. supply from converter to searchlight. 3—Data transmission cables to comparator from sound locator and searchlight. 4—Distant electric control cable from searchlight to controller.

various truck and passenger vehicles. The type finally adopted incorporates a truck chassis modified to incorporate a generator and provided with a special body to meet the requirement for quick and convenient stowage of searchlight and accessories.

The type of truck chassis employed was evolved from a design which has been unusually successful in oil field operations where heavy loads must be transported over terrain impassable to any vehicle not especially designed for the purpose.

It will be observed from Fig. 4 that the searchlight is carried on the truck. Removable channel iron ramps, not shown in the illustration, provide a runway for quickly unloading and loading. A hand-operated winch permanently mounted on the truck makes it possible for one man to perform this operation.

In the course of evolving the antiaircraft searchlight equipment, careful consideration has been given to towing the searchlight with a lighter truck and, alternately, to permanently mounting the searchlight on the truck. Both these expedients were found to involve numerous disadvantages. A truck which has the ability to traverse the terrain encountered in antiaircraft service must be of rugged construction and generous size. Utilizing the body for carrying the searchlight does not add substantially to either size or weight. On the other hand, if the searchlight were towed, it would be necessary to provide it with a heavy chassis which would seriously interfere with ease of handling when placing in position preparatory to antiaircraft action.

If the searchlight were permanently mounted on the truck, it would be necessary to provide some sort of collapsible tower to lift it clear of the truck cab and so give it a clear sweep to all points of the horizon. Such a structure would be excessively heavy and expensive. Moreover, destruction of the searchlight by low flying aircraft would probably result in destruction of the power unit. By separating the two units, the power unit can be concealed at a distance from the searchlight.

The engine of the power unit serves the dual purpose of transporting the equipment and driving the generator which supplies current to the searchlight. As the searchlight cannot be used effectively while being transported, the dual use of the engine is an obvious economy in space, weight and cost.

In coast fortifications where the distances are short and the searchlight and sound locator can be moved from place to place by hand, we have sometimes dispensed with the usual power unit and have

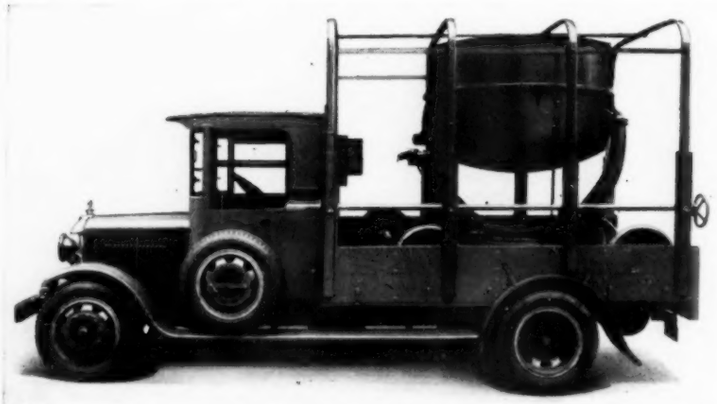

Fig. 4. Truck for Transporting the Antiaircraft Searchlight.

Carrying instead of towing the searchlight makes possible a compact, easily handled searchlight chassis as well as greater speed and maneuverability of the complete outfit. The truck also carries the controller, comparator, all cables, tools, spares, ramps, a winch for loading and unloading and a crew of four men.

provided portable generating equipment. Even in coast fortifications, however, the complete equipment is usually advisable.

The transmission has four forward speeds and one reverse. The propeller shaft from the transmission passes through a hollow generator shaft. The propeller shaft and generator armature are therefore mechanically independent. A clutch is provided which connects the generator directly to the transmission shaft and at the same time disconnects the transmission shaft from the propeller shaft. This clutch is operated by a lever which is conveniently placed in the driver's cab. The speed of the generator is held constant under all loads by an automatic engine governor. When operating as a truck, the governor prevents the driver from exceeding a safe road speed.

Fig. 5. Power Unit Switch Panel for Controlling Current to the Searchlight.

Mounted in the back of the driver's cab is a panel (Fig. 5) which carries the switches, meters, rheostats and fuses for controlling the current to the searchlight. A small rotary converter is provided for transforming a portion of the direct current from the generator into alternating current for the A. C. self-synchronous comparator system.

In addition to facilities for securing the searchlight for transportation, the body of the power unit incorporates reels carrying 600 feet (183 meters) of cable for connecting the generator and searchlight, 200 feet (61 meters) of cable for connecting the searchlight with the control position and 200 feet (61 meters) of cable for connecting the sound locator with the control position. Boxes secured on the power unit carry the controller, comparator, a supply of carbons and a full complement of tools and spare parts.

The rear axle of the power unit carries two wheels on each side. All wheels are of the pressed steel type now recognized as the strongest truck wheel available. The dual rear wheels and extra large balloon tires employed on the power unit give it a tractive effort on bad ground and steep gradients equal to that of a four-wheel-drive truck without the complication of that type of vehicle. As each of the dual wheels is capable of supporting the load, their use adds to the dependability of the vehicle in case of rear tire punctures.

THE function of the sound locator is to ascertain the angular position of approaching aircraft at a maximum range and with a minimum error and to transmit this angular position to the searchlight control. The performance of this function insures picking up the target with a minimum loss of time for searching.

The time available to the defense after the attacking aircraft comes within searchlight range will never exceed five minutes and will frequently be less than two minutes. At least half of this time must be made available to the guns and combat planes. Therefore the time available for researching will not be more than two minutes and sometimes less than one minute.

Consider the problem of picking up attacking aircraft in this short time without the aid of locating devices. The area from which attack may be expected will usually exceed 45 degrees in both azimuth and elevation. The unaided ear has not sufficient range to be of much value. The lights must therefore search the entire area. Each of the beams subtends an angle of about one degree. The beams cannot move rapidly as the eye will not react unless the target is illuminated for an appreciable interval of time. It is obvious that a large number of searchlights will be required to cover the approach area and even then the target will frequently get through without being seen. To provide assurance of illuminating the target in time, some device must be used for ascertaining its direction before it comes within searchlight range.

Two classes of phenomena are available for detecting the direction of aircraft: (1) infra-red radiations, and (2) sound. The numerous elaborate attempts which have been made to utilize infra-red have not met with practical success and there is little possibility that they will until the means for detecting has progressed very much farther than anything now envisioned. Sound, on the other hand, offers a very good medium. Fully half of the sound energy emitted by an airplane comes from the propeller, struts and wings, and cannot be eliminated.

Determining direction by sound depends for its accuracy

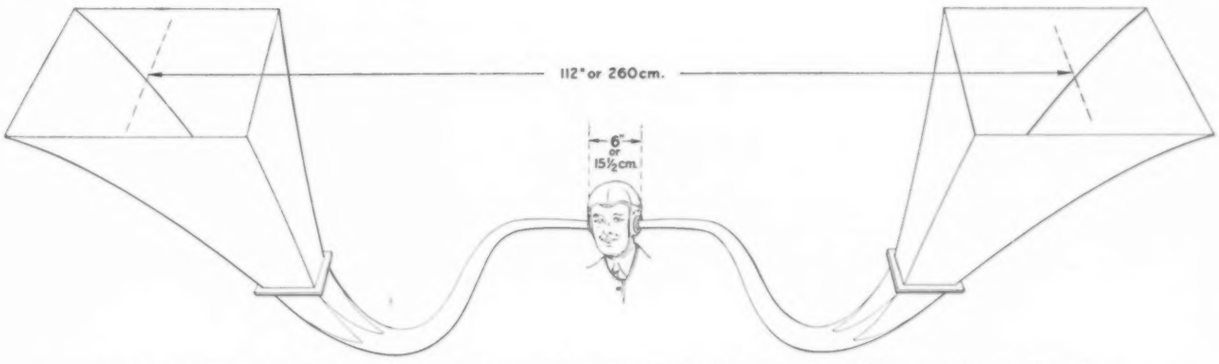

Fig. 6. Accuracy in Defining the Direction of Sound is Proportional to the Distance Between the Ears.
The sound locator extends this distance from 6-inches to 112-inches. The horns aid the binaural effect by giving a rise in volume as the direction of the sound is approached. The combination of the two effects enables the operator to obtain the direction of a fixed sound with an accuracy of ¼-degree.

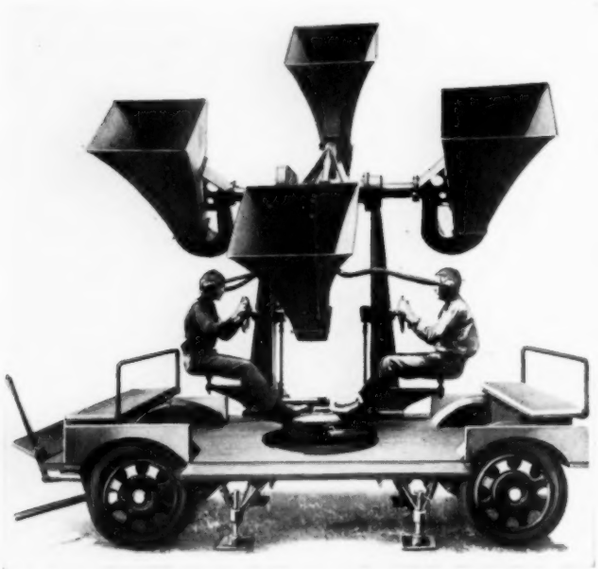

Fig. 7. The Sound Locator Ascertains the Angular Position of the Attacking Aircraft and Automatically Transmits it to the Comparator.

To have range and accuracy and to enable the operators to distinguish between types of airplanes, the sound locator horns must collect **all** airplane sounds and especially the low pitched tones.

on a faculty called the binaural sense. When a normal person hears a sound, he instantly knows, within 10 degrees, the direction from which it comes. If he is completely deaf in one ear, he cannot sense the direction. If he is only partially deaf in one ear, however, he can ascertain direction nearly as well as if both ears were normal. The cerebral mechanism by which direction is ascertained measures the difference in the time of arrival of the sound at the two ears, and from this basic data instinctively determines the angular relation of the sound to the base line between the ears.

In defining the direction of sound, the accuracy obtainable is proportional to the length of the base line between the ears. Therefore, all sound-locating devices extend this base line by placing the horns or other sound collectors as far apart as practicable (Fig. 6). Two pairs of horns are used—one pair for elevation and the other for azimuth. Both pairs are supported by the same structure (Fig. 7) and move together in azimuth and elevation.

The horns should be so designed that they will act as efficient collectors of all airplane sounds. To ascertain the character of these sounds, numerous automatic records have been made. From these records, curves have been plotted showing the sound energy emitted at each frequency. A typical curve made from a record of a single-motored plane is shown in Fig. 8. It will be seen from this curve that fully half of the sound energy occurs in the range between 70 and 250 cycles. Multi-motored bombing planes have an even greater proportion of these low tones.

A consideration of curves such as Fig. 8 makes it evident that the horn or other collector employed in sound locators should respond efficiently to all frequencies above 70 cycles. There are three important reasons for this, i. e.—(1) As more than half of the sound energy emitted by the airplane has frequencies between 70 and 250 cycles, the range of the sound locator will be largely dependent upon the efficiency with which these frequencies are collected and transferred to the ears of the operator. (2) The low frequency (long wave) sounds accentuate the binaural effect. The direction of such sounds therefore can be determined with greater accuracy than is possible with high pitched sounds. Compare, for example, the accuracy with which one can determine the direction of a cricket and a steamship whistle. (3) In the sounds emitted by bombing planes, the very low frequencies predominate. In those emitted by smaller planes, higher frequencies predominate. Unless the horns collect all frequencies efficiently, the operators cannot distinguish between bombing planes and the decoy planes which will frequently accompany them for the purpose of confusing and misleading the ground defense.

The efforts in various countries to develop an efficient sound locator have produced numerous types of sound collecting devices. Those which have attained any degree of success may be divided into four classes, i. e.—(1) Large diaphragms from which the sound is collected by microphones which may or may not be coupled to thermionic valve amplifiers. (2) Parabaloid reflectors or sound mirrors. (3) Multiple cones, i. e., in each collector a number of conical horns, the small ends of which are brought together into a single tube leading to the ear of the operator. (4) The exponential horn.

The diaphragm and microphone type of sound collector was used to some extent in fixed positions during the World War. For a mobile sound locator, however, it is out of the question for two reasons: First, in order to respond efficiently to the low frequencies, the diameter of the diaphram would have to be at least 30 feet; second, microphones of the requisite sensitivity are too unstable for field service.

Regarding the sound mirror type of collector, it has been proven that a parabaloid will not focus sound waves unless its diameter is comparable to the wave length. Even a large parabaloid gives a very broad focus and not a point focus as in the case of light. Consequently, to be efficient at the important low frequencies, it would be necessary for the parabaloid to have a diameter of from 3 to 4 meters. It can readily be seen that a binaural sound locator, with four such parabaloids (two for elevation and two for azimuth), could not easily be made mobile. The largest diameter which can be used in a mobile locator would be about 1 meter. The lowest frequency which this size of parabaloid will focus is about 350 cycles. Therefore a

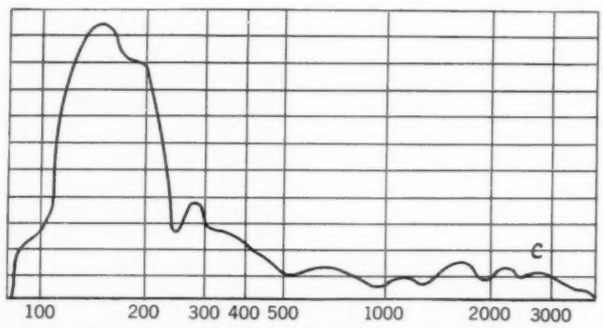

Fig. 8. This Curve Shows the Frequency (tone) Distribution of the Sounds Emanating from a Typical Single-motored Airplane.

It will be observed that more than half of the sound occurs at the low frequencies. A multi-motored bombing plane has an even greater proportion of the low tones. In this figure as well as Fig. 9 the horizontal graduations are frequencies in cycles per second; the vertical coördinates are arbitrary units used in the acoustic laboratory.

device of this character would be efficient at the higher frequencies only, would have a short range and would not enable the operators to distinguish readily between types of planes.

Referring to the multiple cone collector, the endeavor in this case has been to obtain an efficient response to low frequencies by employing a multiplicity of horns in each collector, thus obtaining a large mouth opening while retaining the short length of small horns. In order that the device may be kept mobile, however, it is necessary to restrict the total diameter of each collector to about 1 meter. A considerable amount of space is occupied by the structure between the horns. Therefore the effective mouth opening in each group of horns must be approximately 600 square inches (3,870 sq. c. m.). A considerable loss of sound energy occurs in the great length of tubing which is necessary to connect each group of horns together. The mobile multiple cone will therefore not respond efficiently to frequencies below 1000 cycles.

IN contrast to the three classes of collectors mentioned above, it has been found that an exponential type of horn can be so designed that it will respond efficiently to frequencies as low as 70 cycles and at the same time permit of a mobile structure. An exponential horn is one in which the cross-sectional areas at equal intervals bear constant relations to each other throughout the length of the horn. The superiority of the exponential type of horn as a sound collector has been amply proven by years of work which the large telephone companies have devoted to acoustic research. The information which these companies have made available leaves no room for doubt. The work on sound locators has only confirmed the value of this type of horn for this purpose.

The size of opening and rate of flare of the exponential horn must be such that the sound energy is transferred from the free air to the mouth of the horn and from the mouth through the horn with the least possible loss. It has been found from experience that this is accomplished when the horn mouth has a width at least one-quarter that of the longest wave length which it is desired to receive and a very gradual rate of flare which must be determined by experiment for each type of horn. The size of opening and the rate of flare determine the length of the horn.

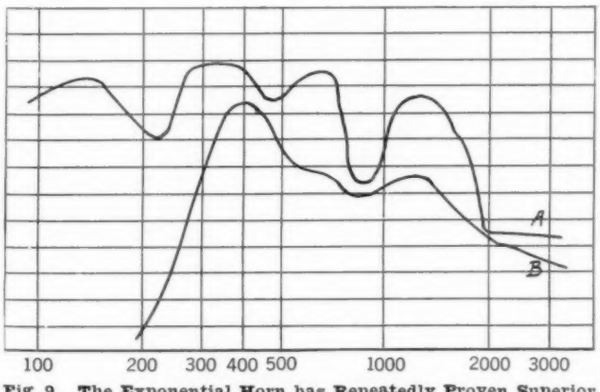

Fig. 9. The Exponential Horn has Repeatedly Proven Superior to All Other Types of Sound Collectors.

When used in sound locators, however, its mouth area, rate of flare and length must be such as to give it high efficiency at the low frequencies. These curves compare the response characteristics of the Sperry horn (A) and a 10-foot exponential horn (B).

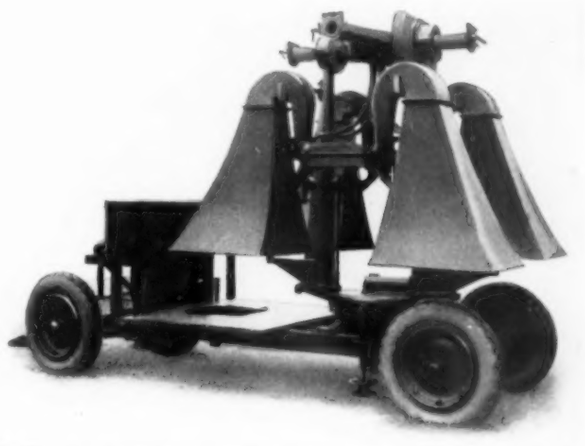

Fig. 10. When Being Transported, the Horns are Stowed in this Manner, thus Decreasing Height. Seats are Provided on the Sound Locator for Transporting its Crew.

The mouth of the horn employed in the Army sound locator has a width of 32 inches (81 c. m.) and an area of 1000 square inches (2,520 sq. c. m.); the flared portion of the horn has a length of 14 feet (4.3 meters); the total length to the operator's ear is about 18 feet (5.5 meters).

The value of this large horn is illustrated by the curves in Fig. 9. Curve A shows the response characteristics of the Army horn. Curve B shows the response characteristics of a 10-foot (3 meters) horn. Compare these curves with Fig. 8 showing airplane sounds. To have any advantage in portability, it would be neccessary to employ a horn much smaller than 10 feet (3 meters). Even a 10-foot horn, however, is so evidently inefficient at the low frequencies that its use would involve serious disadvantages such as short range and inability to distinguish between types of planes.

The response characteristics of the Army horn also show the result of the careful attention which has been given to the details of horn design such as radii of horn bends, material and accurately finished surfaces. Slight differences of this character produce enormous differences in accuracy and range.

In the Sperry sound locator further improvement in directional accuracy is obtained by employing a horn which responds with maximum efficiency when facing the wave front of the sound. This gives rising volume effect similar to that utilized in radio direction finders and, by itself, would permit determination of direction with fair accuracy. The combination of binaural and volume effects makes it quite feasible to ascertain the direction of a fixed source of sound with an accuracy of one-quarter degree. The range at which the Sperry instrument will pick up a target is 24,000 yards (22,000 meters). The range at which it will accurately define direction will be from 12,000 yards (11,000 meters) to 15,000 yards (13,750 meters), depending upon the wind.

HAVING arrived at a satisfactory solution to the problem of accurately defining *apparent direction* at maximum range, it is necessary to correct the sound locator for the difference between apparent direction and true direction. The elements of this problem are shown graphically in Fig. 11.

Referring to the figure, the line LB is the *apparent* direction of the airplane sound. The line LC is the true direction of the airplane at the sound locator, and the line SC is the true direction from the searchlight. It is the azimuth and elevation of the line SC that must be ascertained and transmitted to the comparator and controller.

When the airplane emitted the sound now being heard, it was at the position A. During the interval that the sound took to travel to earth (at the rate of 1100 ft. [330 meters] per second), the airplane moved to C. The error introduced by movement of plane is designated as (1).

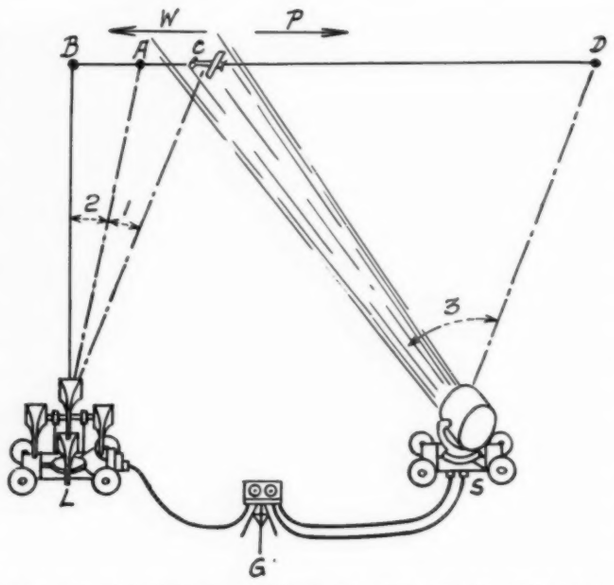

Fig. 11. This Diagram Shows the Elements of the Sound Lag Corrector Problem.

Angle ALB, wind correction; ALC, sound lag correction; CSD, parallax correction; C, present position of plane; A, position when sound now heard was emitted; B, apparent direction of sound due to displacement by wind; W, wind direction; P, path of plane.

During the interval of travel of sound to the horns, the wind blew it in the direction indicated by the arrow W. Thus, when it arrived at the sound locator, the apparent direction was LB. The wind, therefore, introduced an error which is designated as (2).

If we gave the direction LC to the searchlight, it would point in a direction SD, which is parallel to LC. The searchlight, therefore, would have an error which is designated as (3). This error is entirely due to the distance between the sound locator and searchlight (parallax).

For the sake of clearness, Fig. 11 shows the errors in azimuth only and exaggerates them. The errors in elevation are similar to those in azimuth, but under most conditions are very much smaller. In fact, the elevation errors under most conditions can be neglected, in which case it is necessary for the searchlight operator continually but slowly to move his beam up and down a few degrees.

The errors shown are automatically and continuously obtained and applied by an automatic corrector mechanism which forms part of the sound locator. The dials of this automatic calculating device are set for (1) length of base line between sound locator and searchlight, (2) direction of wind, (3) velocity of wind, (4) estimated altitude of plane. Base line is known. Direction and velocity of wind are given by the meteorological station attached to the antiaircraft regiment or may be estimated. Altitude of the plane is estimated by taking into account the atmospheric ceiling, the type of plane and the angular elevation when first heard. The formula for determining the corrections is such as to make errors in estimating altitude relatively unimportant. The most important factor in the correction is the angular velocity of the target.

The angular velocity is determined automatically from the rate at which the sound locator is moved in following the attacking aircraft. This rate, combined with the four settings mentioned above, generates the necessary corrections. The corrections are automatically and continuously applied to the angle which the sound locator transmits to the comparator at the control position. The true position of the attacking aircraft is thus designated to the searchlight controller with an accuracy of 1½ degrees in azimuth. The error in elevation will usually not exceed 3 degrees. Therefore, in finding the target, it is only necessary for the searchlight operator to sweep through an area of 3 degrees in azimuth and elevation. This sweeping operation can be accomplished in a few seconds. When desired, automatic correction can be supplied for elevation as well as azimuth.

THE constructional characteristics of this sound locator will be evident from the illustrations. The horns are connected to the ears of the operators through the medium of leather helmets, which fit their heads comfortably. The helmet has been found far superior to the uncomfortable stethoscope tube formerly employed. In preventing the access of extraneous noise, the helmet is quite as effective as a sound-proof booth.

Several years of experience with this sound locator have demonstrated that it has the following characteristics: (1) a range which is in all cases at least 20 per cent greater than the range of the Sperry 60-inch (152 c. m.) high intensity searchlight; (2) an accuracy on fixed sound sources closer than ¼ degree; (3) maximum response to characteristic aircraft sounds and particularly to the low tones which constitute a large proportion of the sound energy emitted by airplane; (4) undistorted response over a wide range which makes it possible to distinguish various types of airplanes and especially to distinguish the bombing plane from pursuit and combat planes used for decoy purposes; (5) automatic correction for sound lag due to wind and movement of plane as well as correction for parallax between searchlight and sound locator, and (6) simple, rugged construction of such character as to permit towing over rough ground without danger of damage, and operation and maintenance by comparatively untrained personnel.

The tactical employment of searchlights and sound locators cannot be properly discussed in this JOURNAL. The notes on operation submitted here will be confined, therefore, to brief statements covering the usual numerical relations between guns, searchlights and sound locators, the personnel essential to the operation of the searchlight-sound locator unit and the procedure usually followed in making ready for action and operating the equipment.

A searchlight with sound locator is usually called a "pilot light" to distinguish it from a searchlight without a sound locator which is termed an "illuminating light." When using 60-inch (152-c. m.) high intensity searchlights,

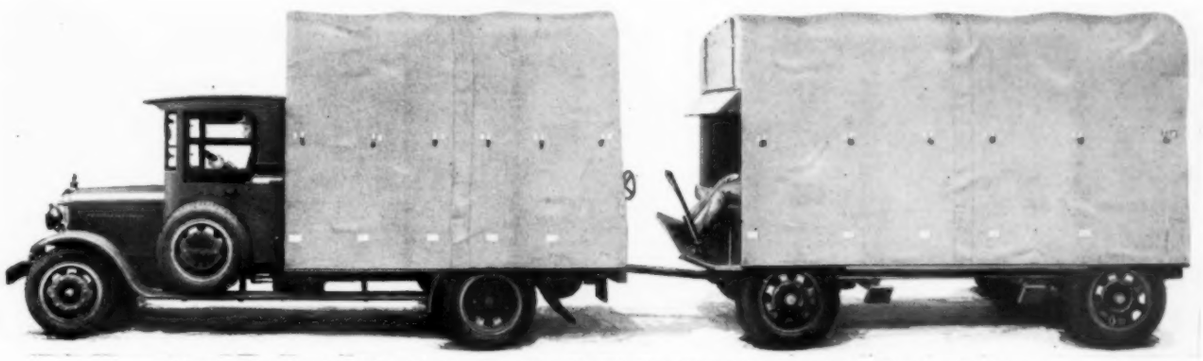

Fig. 12. The Truck Which Carries the Searchlight Also Tows the Sound Locator and its Crew.

the number of lights should be equal to the number of major caliber (3-inch [7.6 c.m.] and larger) guns. In this connection, attention is called to the fact that services employing 36-inch (92-c.m.) searchlights have found it necessary to employ from two to four searchlights for each major caliber gun.

It was thought at one time that one pilot light for each three illuminating lights would be a correct proportion. Experience has shown, however, that the time required to illuminate the target is markedly reduced by making every light a pilot light. From now on, therefore, the usual and best practice will be to employ nothing but pilot lights. All lights may then be used flexibly for holding the target after it is picked up or for searching for new targets.

It has been found in practice that one light very easily can hold a single target or a group flying in formation. Attempts at side slipping or diving out of the beam are seldom successful as the illuminated field is large in comparison with the size of the plane and the beam can be moved very rapidly to follow any movement of the plane.

The personnel essential to the operation of a searchlight-sound locator equipment and their duties are as follows: No. 1—commands the unit, supervises control of searchlight and its coöordination with sound locator; No. 2—drives power unit, operates engine, generator, and power unit switch panel; No. 3—supervises operation of searchlight mechanism; carbons the lamp; manipulates shutter; No. 4—operates distant electrical control under the direction of No. 1; No. 5—operates sound locator in azimuth; No. 6—operates sound locator in elevation, and No. 7—steers and brakes sound locator trailer when being transported, sets data on sound locator corrector and transmits commands to sound locator operators.

Although these men are all that are absolutely essential to the operation of the complete equipment, it is sometimes found that efficiency can be increased by the addition of several others. For example, instead of having the officer or non-commissioned officer in command of the unit wear the telephone head set connecting him with the battery commander, it may be found desirable to have a telephone operator for this purpose. Again, instead of a single operator at the controller, who must watch both pairs of dials of the comparator, it may be found better to have two operators—one for elevation and one for azimuth.

When transporting the equipment, all personnel for the operation of the searchlight and controller are carried on the power unit—three on the front seat and the remainder on a removable seat back of the driver's cab. An additional removable seat is sometimes provided at the rear of the power unit body. The sound locator trailer is provided with removable seats for carrying the personnel assigned to that unit.

The distribution of duties when placing the equipment in position for action and when stowing for transportation after action will depend upon the number of men employed. The time required for these operations will vary with the number of men and the character of the terrain on which the equipment is disposed.

To permit of the accurate coördination of the searchlight with the sound locator, both units must be adjusted to a common base in elevation and azimuth. The common base for elevation is obtained by accurately placing the turntables of both instruments in the horizontal plane. The levels and leveling jacks which form a part of both units provide a convenient and expeditious means for accomplishing this.

For adjusting the searchlight and sound locator to a common base line in azimuth, fixed open sights are provided on both units. The preferred means for carrying out the azimuth adjustment is to place the sights of both units on a designated star or planet and then set the bases and azimuth scales to zero. Another method is to lay the searchlight beam symmetrically on the sound locator and aim the latter at the center of the searchlight. A third method is to aim the open sights of each unit at small signal lights placed in the center of the other unit. When using either of the last two methods, the base and azimuth scale of one unit must be set to read 180 degrees and the other, zero.

The open sight on the searchlight is also used to check the operation of the complete equipment in daylight practice against moving planes.

As the result of many years of field experience, the equipment has been so designed as to require a minimum of attention and to make it possible for mechanically untrained personnel to carry out all maintenance operations including those involving disassembly and assembly.

(This concludes the group of articles on Searchlights and Sound Locators by Messrs. Gillmor and Bassett which have been published serially in this Journal. Part I, "The Fundamentals of Antiaircraft Searchlight Projection," appeared in the March-April, 1930, issue, Vol. X, No. 59, p. 311; and Part II, "The 60-Inch Searchlight-Distant Electrical Control," was published in the May-June issue, Vol. X, No. 60, p. 418.)

The A. S. M. E. In National Defense

The Preparedness Functions of the Mechanical Engineers

By Calvin W. Rice*

THE successful efforts of the past ten years in maintaining the support of industry in the plans of the War Department, and in the development of new methods of ordnance manufacture, show that the Army Ordnance Association is fulfilling its purpose and performing a useful function.

Mobilization of industry in anticipation of national emergency is our Nation's strongest guarantee of peace. This principle, a fundamental of the creed of the Army Ordnance Association, is one to which all citizens subscribe. During the last war, engineers were called on to bear great responsibilities and the members of the profession have a deep interest in emphasizing and re-emphasizing the truth of this principle.

A large number of mechanical engineers were brought into the service of the Ordnance Department by the World War and when, after the emergency, they returned to civilian life and to their activities in The American Society of Mechanical Engineers they retained a strong sympathy for the problems of the Ordnance Department. The ordnance program, requiring several billions of dollars and the putting into production of some five hundred thousand non-commercial items, appealed strongly to the imaginations of the mechanical engineers who, under the splendid guidance of the regular officers of the Ordnance Department, had helped in bringing it well on its way to a successful conclusion when the Armistice was signed.

The understanding by mechanical engineers of the difficulties surrounding ordnance production was reflected in the papers and discussions at the annual meeting of the A. S. M. E. in December, 1919, and a visit of some three hundred members of the Society to the Aberdeen Proving Ground the following week. This was the forerunner of the stimulating Aberdeen pilgrimages conducted since that time by the Army Ordnance Association.

IN 1920 The American Society of Mechanical Engineers revised somewhat its scheme of organization by forming groups called Professional Divisions. The feeling of sympathy with the ordnance problem and the desire to coöperate in order that never again would it have to be faced as an emergency measure, led to the formation of one of these divisions devoted entirely to ordnance. This division functioned actively for several years and focused the attention of the mechanical engineers on the technical problems of ordnance design and production, bringing to the stage of the Society many outstanding men. The names of Williams, Tripp, Joyes, Tschappat, McFarland, Rose, Vail, McMorland, Churchill, and White appear on these programs.

IN 1924 this Society came to a realization of its responsibility to all of the defense arms of the Government and changed the name from the Ordnance Division to the National Defense Division. This division has since carried on an active program of educational meetings devoted very largely to the broader problems of industrial preparedness and ordnance procurement. A series of meetings in Cleveland, Milwaukee, and New York, aroused the enthusiastic interest and support of military and industrial leaders. The list of participants includes Frank A. Scott, Dwight F. Davis, twice during his service as Assistant Secretary of War, Bernard M. Baruch and Benedict Crowell. An event of major importance for which the National Defense Division was responsible was a magnificent session at the 1925 Annual Meeting of the Society presided over by Judge Elbert H. Gary and participated in by Dwight F. Davis, Secretary of War, Hanford MacNider, Assistant Secretary of War, in their first public appearances in these positions, and Generals James G. Harbord and C. P. Summerall.

The four men who have occupied the chairmanship of the Ordnance and National Defense Divisions are Waldo H. Marshall, Fred J. Miller, Frank A. Scott, and James L. Walsh, the present chairman, all leaders in industry with a thorough appreciation of the problems facing the Ordnance Department and extraordinary ability in focusing the enthusiasm of the Society in its aid in their solution. The present executive committee of the Division is made up of J. L. Walsh, Chairman, P. R. Faymonville, Secretary, B. A. Franklin, E. D. Campbell, P. E. Holt and H. I. Cone.

The Society has also been very fortunate in its opportunity for coöperating with the Ordnance Department by enlisting the aid of the seventy-one local sections throughout the country in the work of the fourteen procurement districts of the Ordnance Department. These local sections have provided forums for discussing ordnance and preparedness matters and have been extremely valuable in aiding the work of the Ordnance Department and the Army Ordnance Association. In 1927 in New York, the Metropolitan (New York) Section of the A. S. M. E. visited West Point where, under the leadership of Mr. Charles M. Schwab, then President of the Society, the basic problems of industrial preparedness were discussed with the future leaders of the Army. The Society is extremely pleased to be able to place its facilities at the command of the Ordnance Department and considers it a great honor that the officers in the Second Corps Area have accepted the Council Room of the Society as their regular meeting place.

This intimate ten-year contact between The American Society of Mechanical Engineers and the Army Ordnance Association has borne important results and gives promise of further enthusiastic support in carrying on the work so well started by the Army Ordnance Association.

SUBSTANTIAL progress has been made in the formulation of industrial mobilization plans and if an emergency arose today the Government would undoubtedly be able to reach the desired position of preparedness in one-half to one-quarter the time required in 1917-18. There is still

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much to be done and the Society acknowledges its obligation and pledges its whole-hearted support in carrying on.

The National Defense Division, comprising all citizen members of the Society and numbering some eighteen thousand, provides a ready means for focusing the attention of engineers and industrial leaders on the technical and procurement problems in connection with ordnance. The fields in which the Society may aid seem to be four. First, the dissemination among mechanical engineers and the mechanical industries of information about progress in the industrial preparedness program; second, the mobilization of skilled designers, production men, inspectors, etc.; third, the focusing of technical skill available in the industries on the current problems of ordnance design; and, fourth, in the development of specifications for ordnance material which can be put into production in an emergency with the least possible effort and delay.

Among the members of this Society are engineering and industrial leaders who can aid materially in coöperating with the Government and in disseminating information on the progress of munition development so that American engineers and industrialists may at all times know their responsibility to the common defense. The sessions at meetings of the Society for the past few years which have been devoted largely to this function, under the leadership of Frank A. Scott and James L. Walsh, have been instrumental in bringing about valuable results. The success of any industrial mobilization plan rests on the sympathetic coöperation and complete mutual understanding between industry and the government departments and these can best be brought about by continuing discussions of the problems involved and the means to be taken to arrive at the best solutions. In this function the Society, through its National Defense Division, stands ready to aid the Army Ordnance Association in its continuing programs.

THIS Society possesses information on the qualifications of its members which can be made available to the Government in event of emergency. The success of any emergency plan rests largely on the skill of those who execute it and the Society stands ready to place at the disposal of the Government its knowledge of the skilled technicians and production men of the country who will be required in the event of an emergency. In the late war, the Society established and maintained a complete card catalog of engineers grouped according to qualifications into some 400 divisions. This catalog was consulted continuously by representatives of Government departments. A similar service is available now.

In carrying on its daily work of developing new types of ordnance and of investigating most economical methods of production, the Ordnance Department is faced with engineering and research problems which require the skill of specialists. Through its two hundred technical committees this Society is able to focus the attention of the skill of its membership on these problems and their services are available to the technical departments of the Government on any question that may arise.

IN a recent statement, Mr. Hurley, Secretary of War, said "The industrial war plan must conform to the living body of industry, to its customs, principles, organization, and character." This principle is fundamental and its acceptance by industry places a responsibility upon industry to aid in formulating specifications and designs of ordnance material so that they may be adapted to production with the minimum of time and effort. In turn, it places a responsibility upon the Government to consult industry and be guided by industrial methods in formulating all government specifications. This Society through its many standardization committees and research groups is developing a body of information about industrial practices and customs which is at the disposal of the Ordnance Department in carrying out this function.

Each time the United States has entered a great conflict, it has had to learn again the lesson that adequate industrial preparedness is a fundamental of success. Following the last war, the passage of the National Defense Act of 1920 showed that the Country had been thoroughly impressed with the need for industrial planning. But human memories are short and unless the provisions of the Act are rigorously and continuously prosecuted, the Country may again find itself in a precarious position. The American Society of Mechanical Engineers stands with the Army Ordnance Association and all other similar bodies in support of the efforts of the Government in national defense, firmly believing that adequacy of industrial mobilization plans is the best assurance of continuing peace.

75-mm. Gun Carriage, T2, in Traveling Position, Limbered to Prime Mover.

ARMY ORDNANCE

Published Bimonthly by
THE ARMY ORDNANCE ASSOCIATION
WASHINGTON, D. C.

JULY-AUGUST, 1930

Month by Month

IT is an entirely novel experience to attempt to offer congratulations to a new Chief of Ordnance of the Army. From 1902 to 1930 there were only two individuals who held that high office. When the first of these, General Crozier, was inducted into office, the writer was himself probably the object of felicitations on having completed, without untoward mishap and without exceptional intellectual prowess, his first day at school. When the second, General Williams, took over the command in 1918 ARMY ORDNANCE had not seen the light of day and hence there was no comment about it to be written in this place.

General Hof, Chief of Ordnance

The appointment of General Hof as Chief of Ordnance has the added significance that it is not an everyday event. We say "added" because General Hof's promotion is in itself of pleasing significance. He has had a long and distinguished military career. He has served the Ordnance Department in many of its most important assignments. He possesses in large measure those administrative qualifications so necessary for the successful conduct of his diversified command. He has also the knowledge, experience, and good judgment to warrant that the Department under his direction will continue to merit the esteem which has been rightfully and generally accorded it for so many years. ARMY ORDNANCE extends congratulations to the new chief and to the Ordnance Department.

General Hof was born at Boscobel, Wis., October 24, 1870, and was appointed to the Military Academy from that state in 1890. Upon graduation from West Point in 1894, he was appointed second lieutenant of Cavalry, and assigned to the 6th Cavalry with station at Fort Yellowstone, Wyo., and served with his regiment until 1897. From August 20 of that year until June 7, 1898, he served as instructor of law and history, and later as adjutant of the Military Academy.

During the Spanish-American War, General Hof served again with the 6th Cavalry at Tampa, Fla., and Montauk Point, L. I., and on October 4, 1898, was appointed first lieutenant of Ordnance. Returning to West Point he resumed duty as instructor of law and history until October 17, 1898, when he was transferred to the Watervliet Arsenal. In June, 1899, he was ordered to Sandy Hook Proving Ground, N. J., where he served until transferred to Washington, D. C., in January, 1902, for duty in the Office of the Chief of Ordnance. In April of the same year, he was ordered to Watertown Arsenal, Mass., and on February 17, 1903, was promoted to captain, Ordnance Department. In July, 1904, he was transferred to Frankford Arsenal, Pa., and was promoted to major, Ordnance Department, August 6, 1907. He remained on duty at Frankford Arsenal until July, 1908, when he was transferred to Rock Island Arsenal, Ill. July 15, 1914, he was promoted to lieutenant colonel, Ordnance Department, and in September, 1915, was ordered to the Philippine Islands.

Upon arrival at Manila, he became Department Ordnance Officer, Philippine Department, and Commanding Officer, Manila Ordnance Depot. He was given temporary rank as colonel, Ordnance Department, August 5, 1917, and in February, 1918, returned to the United States for duty as Commanding Officer, Frankford Arsenal, Pa. January 28, 1919, he was promoted to colonel, Ordnance Department, and in March of the same year, was ordered to Washington, D. C., as Acting Chairman, Ordnance Department Claims Board, settling contracts for ordnance cancelled because of termination of hostilities.

In June of the same year, he sailed for France. He returned on August 6, 1919, and continued his duties as Acting Chairman, Ordnance Claims Board, until made Chief of Field Service, Ordnance Department, in November the same year. In August, 1920, he was detailed to the Army War College, Washington, D. C., as student officer, and was graduated the following June.

July 1, 1921, he was detailed in the Office of the Chief of Ordnance as Chief of the Artillery and Automotive Division, and Acting Chief of the Small Arms Division. July 1, 1922, he was again assigned to Field Service, and continued on that duty until July 1, 1925, when he was detailed as student officer, Harvard Graduate School of Business Administration, from which upon graduation, June, 1926, he received the degree of Master in Business Administration.

August 30, 1926, General Hof was transferred to Headquarters, Second Corps Area, Governors Island, N. Y., as Corps Area Ordnance Officer, upon which duty he remained until July 19, 1927, when he was made Assistant Chief of Ordnance, with the rank of brigadier general, and as such became Chief of Field Service.

General Hof was awarded the Distinguished Service Medal. The citation is as follows:

"For exceptionally meritorious and distinguished service in positions of great responsibility, first as Commanding Officer, Frankford Arsenal from March, 1918, to March, 1919, where, by his indefatigable energy, outstanding administrative ability and thorough technical knowledge, he brought to a successful production basis tracer, incendiary, and armor-piercing small arms ammunition, and supplied substantially all that was used by our troops; later, as Acting Chairman of the Ordnance Claims Board, where, by his energy, tact and business ability he secured the settlement of outstanding obligations and later, as Chief of Field Service, Ordnance Department, where he perfected the organization and controlled the disposition of vast quantities of materials and plants left over from the war."

General Tschappat, Assistant Chief of Ordnance

COL. WILLIAM H. TSCHAPPAT, Ord. Dept., until recently on duty as Ordnance Officer, Headquarters of the Philippine Department, was nominated June 2 to be assistant to the Chief of Ordnance with the rank of brigadier general for a term of four years, succeeding as Chief of Field Service of the Ordnance Department, Maj. Gen. Samuel Hof, who became Chief of Ordnance. On the same day on which the President sent Colonel Tschappat's nomination to the Senate that body confirmed the nomination of General Hof to be Chief of Ordnance.

As in the case of the new chief, General Tschappat has been an Ordnance officer virtually all of his career, with the exception of the first few years when he served in the Field Artillery.

General Tschappat was born in Ohio and was appointed to the Military Academy from that state in June, 1892. Upon graduation from West Point in 1896, he was commissioned second lieutenant of Artillery and assigned to the 5th Artillery at Fort Slocum, New York. On March 19, 1898, he was transferred to Fort Hancock, N. J., and served at that station until June 20 of the same year, when he was ordered to Fort Hamilton, N. Y.

He continued on duty at Watertown Arsenal until August, 1900, when he was transferred to the Office of the Chief of Ordnance at Washington. In October, 1901, he was ordered to duty at Sandy Hook Proving Ground, Fort Hancock. On February 16, 1903, he was promoted to captain, Ordnance Department. In June of the same year he was detailed as inspector of ordnance, Bethlehem Steel Company, and continued on that duty until 1906.

In September, 1906, General Tschappat was ordered to Cuba as Chief Ordnance Officer, Army of Cuban Pacification and Depot Ordnance Officer, Havana, Cuba. In May, 1907, he returned to the United States for duty at Picatinny Arsenal, Dover, N. J. On September 19, the same year, he was promoted to major, Ordnance Department, remaining on duty at Picatinny Arsenal until August, 1912, when he was detailed at the Military Academy as Professor of Ordnance and Gunnery. While on this duty he prepared and published Tschappat's "Ordnance and Gunnery" the standard text on the subject during the World War and until last year when McFarland's text, revising and bringing up to date its predecessors was published. August 17, 1915, he was promoted to lieutenant colonel, Ordnance Department, and in July, 1917, was transferred to Port of Embarkation, Newport News, Va., as Ordnance Officer of the port. January 11, 1918, he was appointed colonel, Ordnance Department, National Army, and in February of that year returned to the Military Academy for a continuation of his duty as Professor of Ordnance and Gunnery. July 8, 1918, he was again transferred to Washington, D. C., for duty in the Office of Chief of Ordnance, where he performed the duties of Assistant to the Chief of the Nitrate Division and later as officer in charge of the Personnel Section, Administration Division. June 9, 1919, he was made Chief of the Ordnance Theory, Instruments and Metallurgy Division of the Technical Staff and remained on that duty until July, 1921, when he was made Chief, Ballistics and Ordnance Theory Division of the Technical Staff. On July 1, 1922, General Tschappat became Commanding Officer of the Aberdeen Proving Ground, Aberdeen, Md. He remained at Aberdeen until June 30, 1925, when he was again ordered to Washington for duty in the Office of Chief of Ordnance as Chief of the Technical Staff.

September 12, 1929, General Tschappat sailed for Manila, where, at the time of promotion to be Assistant to the Chief of Ordnance, he was on duty as Ordnance Officer, Headquarters of the Philippine Department.

ARMY ORDNANCE felicitates the new Assistant Chief of Ordnance upon his richly deserved honor.

Wartime Draft to be Studied

ON June 20 the House of Representatives passed the amended bill (H. J. Res. 251) proposing the creation of a commission to consider amendment of the Federal Constitution to minimize the profits of war and to study policies in event of war. The resolution often referred to as the "universal draft bill" was passed by the House April 1st and by the Senate, amended, June 2nd. The Senate amendment struck out the words "without profit" and the phrase "so as to empower the President immediately to mobilize all the resources of the country" from the phraseology. As finally disposed of in the House accepting these amendments by a vote of 187 to 117, the resolution would create a commission comprising four representatives and four senators, the Secretaries of War, Navy, Agriculture, Commerce and Labor and the Attorney General, to study and consider a constitutional amendment, "to provide that private property may be taken by Congress for public use during war and methods of equalizing the burdens and to remove the profits of war together with a study of the policy to be pursued in the event of war." The bill as amended and as submitted to the President for signature eliminates a provision of the earlier text which included five civilians on the commission.

The measure had the unqualified backing of the American Legion and it is hoped that after it has become a law and the commission begins its activities every phase of the intricate procedure of industrial mobilization will be thoroughly and fairly examined. We take it that under the guidance of the commission many of the heretical and warped ideas regarding a universal draft will not be given the overemphasis they have received in recent years.

Coincidentally *National Defense*, journal of the American Legion, Department of Illinois, published the following which is of note:

"The Reed-Wainwright Bill now before Congress that The American Legion is backing, is sometimes referred to as the Universal Service Act or the Universal Draft Act, and is generally misunderstood by many people. It is well to call attention to the fact that in this bill The Legion is sponsoring, *we do not ask for the conscription of capital, industry or labor.*

"What The American Legion is urging in the Reed-Wainwright Bill is this: that Congress appoint a commission consisting of four members of the United States Senate, four members of the House of Representatives, the Secretaries of War, Navy, Labor, Commerce and Agriculture, along with five other men in connection with the above, but which will represent capital, labor, industry and provisions for the farmer. This committee is to make a thorough study and investigation in regard to the possibili-

ties of perfecting the National Defense Act as pointed out by National Commander Bodenhamer in his article in this issue of the *National Defense Magazine*, and report back to Congress their findings. The American Legion then will ask Congress to work out to the best of their ability, legislation that will embody the recommendations of this commission to perfect the National Defense Act of 1920.

"It should be clearly understood from this explanation that The American Legion is not asking or recommending to Congress any specific action at this time other than the appointment of a body to make this survey."

The Officers' Reserve.

THE recurrence of the annual summer training camps for Ordnance reserve officers to be held at various arsenals and at the Aberdeen Proving Ground during July and August suggests again the importance of the civilian component of the Army. That the citizen soldier of today be the minute man of old requires slightly more than that he keep his trusty musket handy in the chimney corner and his powder horn in a cool, dry place. Indeed, the needs of a modern age demand that more emphasis be placed upon the musket itself and the powder than upon the man, that more security be given the what and why of the arm than the how and where of its use. As James L. Walsh, the first editor of this Journal, so well emphasizes in a contribution in this issue, the problem of the design of ordnance far transcends the problem of its use.

And so we feel that the reserve officers who, often at a personal sacrifice, take the time and trouble to devote a fortnight to intensified study are worthy of our thanks and commendation. It is too bad that requirements of the law make it difficult to secure more trainees and more frequent training periods. We should like to see it practicable to train every Ordnance reserve officer at least once in every two years. We hope that will be possible some day. Until then full quotas of reservists can well be taken as an outward sign of an important movement which connotes the safety and sensibleness of the entire ordnance preparedness program.

As long as there are reservists in training the things for which they stand are live and dominant factors—as their number grows so also will the value of their effects.

The Navy Cuts Adrift

IT is no new thing to see the Navy deliver the goods—that has been its penchant in season and out of season since the days of John Paul Jones. No odium is meant when we contrast the way the Army does things with the methods of the Navy. Without citing cases we imagine there will be little contest of the statement that the Navy wins by lengths.

The most recent evidence of this results from the Senate hearings on the London Treaty. Mind you, big or little navy is not the concern of our remarks, whether ratios provided by the proposed treaty are fair or unfair is not in point. The fact, though, of ranking Naval officers appearing—almost to a man—to voice their convictions on a measure of international import in the face of strong opposition pressure is a thing to cause every man's son of us to take hats off to the Navy. The military and naval professions are not in the day's work. They are specialties in every sense. Those who specialize in them are as much entitled to an expression of professional opinion as are the surgeon and the attorney.

That professional opinion should be given a value befitting its worth. To forbid its expression or to be irked at it is little consolation. The Navy on things naval should have its say and we admire those officers who in the face of official censure are fearless about it. National Defense is the gainer when professional opinion is expressed and the sanity and good judgment of the people are allowed to decide upon the evidence. In that respect the English have the far better system. But, fancy a distinguished officer addressing the ladies and gentlemen of the House of Representatives on the need for light tanks or army housing. It isn't done. Thanks to the Navy for its conception of duty and its devotion to principle as the Navy sees it. Would that there were more of it—and in the Army.

The T-2 Gun Mount

WE have to thank Captain Goebert for his enlightening article in this issue on the new gun mount known as the T-2. In the last issue of this Journal Maj. G. M. Barnes described another similar mount, the T-3. Both seem to have much merit. Which is the better intrinsically and which is predicated on better principles we do not attempt to decide. Expert technical opinion and test will determine that.

It is significant and worthy of note, however, that two schools of thought are at work on the problem. So long as there is discussion and trial to meet differing viewpoints ordnance design is progressing. There is no greater stimulus to progress than full and frank interchange of ideas. Provide for that and the best there is will follow.

Plans for Our Annual Meeting

THE Twelfth Annual Meeting of the Army Ordnance Association will be held on October 8th and 9th beginning with a business and technical session in Washington, D. C., to be addressed by officials and engineers of national prominence on the evening of October 8th and to be followed by the usual program of tests and exhibits at the Aberdeen Proving Ground, Md., on October 9th. Complete details will be sent all members in good time.

Changes from the established order are brought because in former years it has been next to impossible to hold a worth-while business and technical meeting at the Proving Ground as there is seldom sufficient time on a program already completely filled with tests and exhibits. Consequently this year's plans provide for an evening in Washington devoted to interesting discussions on ordnance and related subjects.

As to the portion of the meeting to be held at Aberdeen, it is planned this year to restrict attendance to members of the Army Ordnance Association and their guests. Well founded complaint has been registered in the past to the large attendance, itself defeating the educational and scientific purposes of the gathering. The meeting is intended for members of the Association and we hope through the necessary precautions to restrict it in this respect. Notices and complete information will be sent all members about the first of September. Members are asked to arrange their plans to attend both the Washington and Aberdeen functions.

Ten Years of Army Ordnance

An Editorial

WHETHER we like birthdays or not custom decrees that their observance is altogether fitting and proper. ARMY ORDNANCE not having reached the jovial period of fair, fat and forty, may coyly announce that it is now ten years old and embarks upon the eleventh year of its healthy youth with soundness of body and the same high purpose with which it was endowed at birth. The passing of the ten-year marker is an occasion of happy retrospect in which all members of the Association may indulge with just a little of that feeling of successful achievement. The degree of success may be a moot question. It ill becomes us to debate that. It is appropriate, however, that we look back that we may the more surely look ahead.

In July, 1920, when this journal made its bow, the need for some vehicle of information for the great body of American industry which had but recently undergone its baptism of fire in the World War was glaringly apparent. Unless there was to be some such medium then that close and essential degree of contact between potential munitions engineers, designers and manufacturers on the one hand and the Government authorities on the other, could not long continue. As a vehicle for the then newly founded Army Ordnance Association such a journal became a necessity. The Association itself needed it if the objectives of the organization were to attain fulfillment. The National Defense Act then being revised to provide more definitely for industrial mobilization could well stand the impetus of an impartial organ aimed essentially to assist it. These were the reasons why ARMY ORDNANCE was founded. Experience has shown them to be sufficient enough.

Of course there were conscientious objectors to so untried and, as they intimated, unnecessary and indeed harmful a venture. To discuss in the cold, printed word the activities of our military organization insofar as they relate to descriptions of new weapons and new processes was looked upon by some as well-nigh heretical. It had been customary in the past to regard as extreme secrets each little improvement of any of our American weapons. Such things were usually rubber stamped "secret and confidential" and reposed securely in the vaults of the War Department. To pry them loose was an impossible task. With the end of the World War, however, a new outlook as to such things arose. If we were to keep American industry informed of munitions developments obviously American industry must have some means of knowing about them. True enough not every activity relating to munitions development has been described in print. There must always be confidential activities in this field as in every other. However, at least there was a broadening viewpoint which departed from the old narrow policy of secrecy. The big objective was to inform American manufacturers, and this during the past ten years has been fulfilled.

THE first editor of ARMY ORDNANCE was James L. Walsh whose energy, ability and sound judgment were responsible for the successful launching of the Journal. By reason of his wide industrial and military experience he brought to his new office a wealth of vision without which the new undertaking could never have been begun so auspiciously. He established the present form and general context of the publication from which it has departed only in minor exceptions. After several years as editor he was succeeded by Maj. R. H. Somers who continued the publication on the same high scale begun by his predecessor. Few men have the affable and unassuming characteristics of (as we like to call him) "H. R. H." Somers. His kindly personality and thorough knowledge of ordnance affairs blended into the pages of ARMY ORDNANCE and gave it that personal characteristic so essential in an organ of a nation-wide society.

The third editor was Maj. R. L. Maxwell who during the year in which he was in charge of the publication gave unstintingly of his energy toward maintaining and improving the Journal. Major Maxwell had served in important ordnance assignments and through his many Army contacts was able to broaden the field of text and the general outlook of the discussion. Maj. Chas. R. Baxter was the fourth editor and served in this capacity until October, 1929. Of keen business judgment and of responsible experience at many ordnance establishments, he was successful in bringing to culmination the efforts of practically the first ten years and in establishing the journal on the soundest financial status of its experience.

Under the editorial guidance of these men the Journal received an endowment of good judgment and performance which, it is hoped, will never be erased from its record.

DURING the past decade ARMY ORDNANCE has listed among its contributors outstanding characters of Governmental, industrial and financial standing. It has discussed practically all of the important developments relating to munitions progress and industrial preparedness, its chosen field. It has kept in the forefront such important questions as the mechanization of armies and antiaircraft progress. It has endeavored to treat impartially the many fields of which ordnance is a part so that all readers, no matter what their particular forte, might be acquainted with the current status of the ramified activities of the organization.

In typography, quality and quantity of illustrations, constant improvement has been sought. The publication has been fortunate in securing cover designs of the late Joseph Pennell and the present series from the eminent artist, Mr. Vernon Howe Bailey.

And what shall we say of the future? Only this, that, with the continued coöperation of all, the years to come portend even greater things. The days of pioneering are over, the short-lived impetus of war is gone, the period of steady broadening based on experience is at hand. May the next ten years see even greater idealistic and material advancement. May they continue the open mind, the alert analysis, the substantial progress. May they bring an even deeper and more general realization of the industrial and scientific bases of our defense system. One thing is sure, they cannot bring a finer degree of esprit than that of the pioneers, those who founded upon good ground.

Association Affairs

Notice of Nominations

IN accordance with the by-laws of the Army Ordnance Association, the biennial election of officers, President, two Vice-Presidents and three Directors for terms beginning January 1, 1931, will be held by general ballot closing September 2, 1930. The by-laws provide as follows:

"Nominations

"20. A Nominating Committee of five (5) members shall be appointed by the President on or before June 1st of each year in which elections are to be held. This Committee shall deliver to the Executive Secretary in writing on or before July 1st, the names of its nominees for the elective offices next falling vacant in the Association. The Executive Secretary will communicate with each nominee. In the case of the declination of any nominee to accept his nomination, the Executive Secretary shall report the fact of such declination to the Nominating Committee which will then nominate another member for the office.

"21. Nominations also may be made by petition signed by not less than 5 per cent of the entire membership of the Association, which petition must be filed with the Executive Secretary together with the written acceptance of the nominations by the nominees, prior to July 20th.

Pistol Trophy Presented by Reserve Officers of New York Ordnance District for Competition at Aberdeen Proving Ground Annual Training Camps.

Elections

"22. The Executive Secretary shall mail on or before July 31st to each member entitled to vote a ballot stating the names of the candidates for the several offices falling vacant, and the time of the closure of the voting. The voter shall prepare his ballot by marking the same opposite the names of the respective candidates of his choice or by crossing out the name of any candidate or candidates rejected by him, and may write in the name of any eligible member of the Association. In no event shall the voter mark his ballot for more candidates than there are offices to be filled. The voter shall enclose ballot in an envelope and seal the same. He shall then enclose the sealed envelope in a second marked Ballot for Officers, seal the same, and shall then write his name thereon for identification. The ballot thus prepared and enclosed shall be mailed or delivered unopened to the Executive Secretary of the Association.

"Tellers

"23. The President shall, on or before July 31st of each year in which elections are to be held, appoint three tellers of Election of Officers whose duty shall be to canvass the votes cast and certify the same to the President or Presiding Officer at the first subsequent session of the Board of Trustees. The term of office of the Tellers shall expire when their report of the canvass has been presented and accepted.

"24. The Executive Secretary shall certify to the competency and signature of all voters, and shall deliver unopened all ballots to the Tellers of Election. Ballots without the endorsement of the voter written on the outside envelope are defective. Ballots which contain more names than there are offices to be filled are thereby defective, and shall be rejected by the Tellers of Election.

"25. The voting for the election of officers shall close at 12 o'clock noon on the first Tuesday in September in each year. The Tellers shall not receive any ballot after the stated time for the closing of the voting. The Tellers of Election shall first open and destroy the outer envelopes and shall then open the inner ones, canvass the ballots and certify the result to the President or Presiding Officer at the next succeeding session of the Board of Trustees. The President or Presiding Officer shall then announce the candidates having the greatest number of votes for their respective offices and declare them elected for the ensuing term.

"26. The names of the candidates proposed by the Nominating Committee and the names, if any, of members nominated by petition, and the respective offices for which they are candidates shall be printed in separate lists on the same ballot sheet.

"27. In case of a tie in the vote for any officer, the President, or, in his absence, the Presiding Officer of the Board of Trustees, shall cast the deciding vote."

A Nominating Committee selected from among the officials of the local posts of the Association has been appointed by the President. The members of the Nominating Committee are:

James L. Walsh, President, New York Post, Chairman;
A. K. Hamilton, President, Chicago Post;
Taylor Allderdice, President, Pittsburgh Post;
Bruce Cornwall, Director, California Post;
Spencer G. Kuhn, President, Cincinnati Post.

The nominees selected by the Committee are as follows:

For President

BENEDICT CROWELL, Cleveland, Ohio.

Mining engineer. Ph. B., Yale, 1891; M. A., 1918; The Assistant Secretary of War and Director of Munitions dur-

ing the World War. Steel production survey on General Munitions Board, Washington, 1917; Major, Engineer R. C., August, 1917; in charge of Washington office of the Panama Canal, resigned upon appointment as Assistant Secretary of War, November, 1917; in charge of engineering and Munitions Board war preparations to provide arms and munitions for all military forces. Appointed Director of Munitions, 1918; resigned as Assistant Secretary of War, 1920. Chairman of board, Crowell and Little Construction Co., Cleveland. President of the Army Ordnance Association (since 1919); President, National Rifle Association; Member American Institute of Mining and Metallurgical Engineers, Mining and Metallurgical Society of America, Lake Superior Mining Institute, American Iron and Steel Institute, Canadian Mining Institute, and Cleveland Historical Society, etc. Author: (With Charles B. Murray) "Iron Ores of Lake Superior" (6th edition), 1927; (with Robert Forrest Wilson) "How America Went to War" (6 volumes in complete series) 1921. Charter member, Army Ordnance Association.

For Vice-Presidents

WILLIAM W. COLEMAN, Milwaukee, Wis.

Manufacturing engineer. B. S. in metallurgy, Lehigh University, 1895; with Bethlehem Steel Company, 1895-1902; Crucible Steel Company and Latrobe Steel and Coupler Company, 1902-05; Bucyrus Company (now Bucyrus-Erie Company), manufacturers of machinery since 1905, President since 1911; Director, Marshall and Ilsley Bank, Milwaukee Electric Light and Railway Co., Nordberg Manufacturing Co. Appointed Special Assistant to Chief of Ordnance, U. S. Army, Washington, D. C., 1918; Colonel, Ordnance Reserve. Trustee, Milwaukee-Downer College; Director, Columbia Hospital. Member American Society of Mechanical Engineers, Iron and Steel Institute (Great Britain), American Academy of Political and Social Science. Charter member, Army Ordnance Association.

WILLIAM C. SPRUANCE, Wilmington, Del.

Electrical engineer. Princeton University, 1894, E. E., 1895. Consulting practice until 1903; with duPont Company since 1903 except when in military service; Vice-President, E. I. duPont de Nemours & Co.; Chairman of Board, duPont Rayon Co., duPont Cellophane Co., Inc.; Director, duPont Viscoloid Co. Major, Ordnance Department, U. S. Army, December, 1917; Lieutenant Colonel, January, 1918; Colonel, October, 1918. Served as Chief of Explosives and Loading Division, Ordnance Department; member Commodity Section on Explosives, War Industries Board and Committee on Explosives Investigation, National Research Council. Honorably discharged, February, 1919. Member American Institute of Electrical Engineers, American Society of Mechanical Engineers, American Institute of Mining and Metallurgical Engineers, American Academy of Political and Social Science, Franklin Institute, Princeton Engineering Association. Awarded D. S. M. (U. S.), 1919. Charter member, Army Ordnance Association.

For Directors

SAMUEL MCROBERTS, New York, N. Y.

Banker. A. B., Baker University, Kansas, 1891, A. M., 1894; LL.B., University of Michigan, 1893. Practiced law at Chicago, 1893-95; attorney for Armour & Co., Chicago, 1895-1900, with financial department 1900-04, treasurer, 1904-09, now Chairman Finance Committee; Vice-President, National City Bank, New York, 1909-19; President of Metropolitan Trust Co. of N. Y., 1921-25; Chairman of Board, Chatham-Phenix National Bank and Trust Co.; Director of Consolidation Coal Co., Austin Machinery Corp., American Sugar Refining Co., National Surety Co., Great American Insurance Co., American Alliance Insurance Co., Massachusetts Fire and Marine Insurance Co., N. Y. Indemnity Co., Cartier, Inc., New York Air Brake Co., Consolidated Cigar Corp., Chicago, Milwaukee & St. Paul Railroad, K. C. S. Railroad, Cumberland and Pennsylvania Railroad Co., etc. Major, Ordnance Department, November, 1917; Colonel, November 28, 1917; Chief of Procurement Division of Ordnance Department, Washington; Brigadier General, August 26, 1918; transferred to A. E. F. until end of war; honorably discharged, January 15, 1919; now Brigadier General, Ordnance Reserve. Awarded D. S. M.; Chevalier, Legion of Honor (France). Treasurer, Board of Trustees, Y. M. C. A. (New York); Trustee, Baker University. Charter member, Army Ordnance Association.

PLINY E. HOLT, Stockton, Calif.

Engineer and manufacturer. Born Concord, N. H., educated University of Minnesota. Associated with Holt Manufacturing Co., 1896; established Holt Caterpillar Co., Peoria, Ill., 1909. Vice-President and General Manager, Consolidated Holt Companies, 1913, Stockton, Calif. Resigned 1916 because of ill health. Assisted Ordnance Department, U. S. Army, in design of 2½- and 10-ton ordnance caterpillar tractor at Peoria plant. Joined Ordnance Department in Washington, 1918, in charge of design and production of self-propelled gun carriages on staff of Engineering Division. After World War returned to Stockton as Vice-President in charge of engineering, The Holt Company; now director, Caterpillar Tractor Company. Charter member, Army Ordnance Association. President, California Post.

C. C. WILLIAMS, Washington, D. C.

Formerly Chief of Ordnance, U. S. Army. Graduate U. S. Military Academy, 1894, Artillery School, 1898; 2nd Lieutenant, 4th Artillery, June 12, 1894; promoted through grades to Major General, July 16, 1918; served as Brigadier General and Major General, 1917-18, World War. Joined Astor Battery, May, 1898, and served in Philippine Islands; duty at Rock Island (Ill.) Arsenal, 1898-1899; Inspector of powder, duPont Powder Mills, Wilmington, Del., 1899-1902; Assistant to the Chief of Ordnance, 1902-1904; at Rock Island Arsenal, 1904-06; Chief Ordnance Officer, A. E. F., in France, June, 1917-April, 1918; Acting Chief of Ordnance, April, 1918; Chief of Ordnance, July, 1918-April, 1930. Awarded D. S. M., 1919; Officer Legion of Honor (France), 1919, Commander same, 1921; Companion St. Michael and St. George (British), 1919; Commander Order Polonia Restituta (Polish), 1923. Member Society of Carabao. Charter member, Army Ordnance Association.

In conformity with the above provisions of the by-laws, ballots will be mailed on July 31st to all members of the Association entitled to vote. Independent nominations, as provided for in the by-laws, may be made by petition signed by not less than 5 per cent of the entire member-

ship of the Association, which petition must be filed with the Executive Secretary together with the written acceptance of the nominations by the nominees prior to July 20th.

Washington Post

THE May meeting of the Washington Post, Army Ordnance Association, which took the form of a joint gathering with the Washington Post, American Society of Military Engineers, at which the honor guest was the new Assistant Secretary of War, Col. Frederick H. Payne, was held at the Army, Navy and Marine Corps Country Club at noon Friday, May 16th. One hundred and forty members and guests were present.

Lt. Col. C. G. Mettler, Ord. Dept., President of the Washington Post, Army Ordnance Association, presided. At the speakers' table, in addition to Colonel Payne, were Gen. Chas. P. Summerall, Chief of Staff, U. S. Army; Maj. Gen. James E. Fechét, Chief of Air Corps; Maj. Gen. Lytle Brown, Chief of Engineers; Brig. Gen. George Van H. Moseley, Executive Assistant to the Assistant Secretary of War; Brig. Gen. C. L'H. Ruggles, then Acting Chief of Ordnance; and Brig. Gen. Samuel Hof, then Assistant to the Chief of Ordnance.

Addresses were made by Colonel Payne, General Summerall and General Fechét. Colonel Payne, a charter member of the Army Ordnance Association and formerly Assistant District Chief of the Bridgeport Ordnance District, emphasized the need for a broader understanding of industrial preparedness and for educational orders for munitions. General Summerall paid tribute to the members of both associations and to the branches of the Army with which they are identified. He praised the Ordnance Department for its splendid work in the development of tanks, semiautomatic rifles, antiaircraft equipment and its recent metallurgical progress. He also praised the Corps of Engineers for the work being done under its direction throughout the country for flood relief, the development of inland waterways and river and harbor advancement.

General Fechét, in characteristic mood, spoke of the coöperation between the Air Corps and the Corps of Engineers and the Ordnance Department and complimented the latter especially on the development of bombs and other equipment for use by the Army Air Corps. The meeting was the most successful yet held under the auspices of the Washington Post.

Election of Officers, Boston Post, A. O. A.

AT the annual meeting of the Boston Post, Army Ordnance Association, on May 9, 1930, the following officers and directors were elected: *President:* Maj. R. F. Whitelegg; *Vice-President:* Maj. Nathaniel C. Nash, Jr.; *Directors to serve two years:* George L. Gilmore, Everett Morss, Capt. George P. Slade; *Director to serve the unexpired term of Major Nash:* Col. James F. Monaghan. Other directors of the Boston Post are: Col. Edward F. Miller and Lt. Col. James S. Smyser.

Election of Officers, New York Post, A. O. A.

AT a meeting of the New York Post, Army Ordnance Association, held on April 19, 1930, the following officers were elected for a term of two years: *President:* James L. Walsh; *First Vice President:* Samuel McRoberts; *Second Vice-President:* H. B. Machen; *Third Vice-President:* F. W. Roller; *Fourth Vice-President:* J. E. McNary; *Secretary:* Philip R. Faymonville; *Treasurer:* Charles W. Reed; *Executive Committee:* the Officers and Charles Elliot Warren, John Ross Delafield, J. M. Boyle, C. T. Harris, Jr., C. W. Rice and T. A. Morgan.

Bridgeport

IN May of each year, the Bridgeport Ordnance District conducts an annual war game which is followed, in June, by the annual meeting of the district. The war game for 1930 was held in the district office from April 27th to May 10th. Seven reserve officers representing the various divisions of the district office were on active duty during the war game. Every officer assigned to the district reported during the period either in person or by letter, telephone, telegram, or cablegram. A number of officers not on active duty, including all of the chiefs of divisions, visited the office during the period and participated in the exercises. Officers of the several production divisions analyzed the factory plans of the district and prepared reports on these plans which are incorporated in the war game report.

The sixth annual meeting of the Bridgeport District was held at the Hotel Bond, Hartford, Conn., on June 6th. The District Chief, Colonel B. A. Franklin, Ord. Res., presided at the meeting. Lieut. Col. Frederick H. Payne, The Assistant Secretary of War, and formerly Assistant Chief of the Bridgeport District, was the honor guest and delivered an address on the plans of the War Department for Industrial Preparedness. Of particular interest was his outline of the organization which it is proposed to set up in time of war to direct and coördinate the procurement activities of the military forces of the Country.

Col. Edwin D. Bricker, Ord. Dept., Chief of the Technical Staff, Office of the Chief of Ordnance, attended the meeting as the personal representative of the Chief of Ordnance. Colonel Bricker gave a most interesting talk on post-war developments of ordnance.

The following officers of the Regular Army were present at the meeting: Col. J. W. Joyes, Commanding Officer, Springfield Armory; Col. Ira F. Fravel, New York Air Corps Procurement Planning Representative; Maj. John G. Booton, Executive Assistant, Boston District Ordnance Office; Capt. F. A. McMahon, Executive Assistant, Pittsburgh District Ordnance Office; Lieut. Col. J. L. Holcombe, representing the Chief of Staff, 76th Division, Organized Reserves; Capt. G. A. Woody, Springfield Armory; and Maj. J. K. Clement and Lieut. P. L. Deylitz, Bridgeport District Ordnance Office.

Other guests and speakers at the meeting included Mr. John H. Goss, Vice-President, Scovill Manufacturing Company, Waterbury, Conn.; Col. L. J. Herrmann, Works Manager, Remington Arms Company, Bridgeport, Conn.; Mr. H. H. Pease, President, The New Britain-Gridley Machine Company, New Britain, Conn.; Mr. S. M. Stone, President, Colt's Patent Fire Arms Mfg. Company, Hartford, Conn.; and Mr. W. R. Webster, Vice-President, Bridgeport Brass Company, Bridgeport.

This meeting was the largest in point of attendance that the district has held, approximately 190 officers and manufacturers being in attendance. All of the important manu-

facturers who have coöperated in the work of the district were represented by one or more of their officials.

Reports were made by the chiefs of the several divisions of the district office on the progress of the work of their divisions during the past year. The Executive Assistant discussed some of the outstanding problems of the district and mentioned particularly the machinery problem and the work of the accounting section in its study of the War Department Adjusted Compensation Contract Form.

Preceding the meeting of the district, the annual meeting of the District Advisory Board was held at the Hartford Club at 3:30 P. M. Colonel Franklin presided at the meeting. The Assistant Secretary of War and Colonel Bricker, representing the Chief of Ordnance, attended the meeting and participated actively in the proceedings.

Association Membership

THE Association has its government vested in a Board of Directors, six of whom are elected by general ballot of the entire membership, for terms of four years, and one director representing each local post, the latter being elected by the respective posts. The officers, with one director elected by the Board of Directors, constitute the Board of Trustees which has the active management of the affairs of the Association. The President and Vice-Presidents are elected every two years by general ballot and the Counsel, Treasurer and Executive Secretary are appointed by the Board of Directors. The Association was incorporated in 1928 under the laws of the District of Columbia.

Over 90 per cent of the membership of the Association consists of executives and engineers of American industry who are cognizant of the importance of industrial preparedness. These gentlemen who, through affiliation with the Association are kept informed of current development of munitions, constitute a large portion of the civilian nucleus upon whom our Government will depend for the manufacture of ordnance in time of emergency.

The following extracts from the Constitution and By-Laws of the Association define the several classes of membership.

"SEC. 1. Full membership in the Association shall be open to all men who are American citizens and who are interested in promoting the cause of industrial preparedness, particularly in connection with the design, procurement, production, manufacture, inspection, test or supply of ordnance material.

"SEC. 2. Life membership in the Association shall be open to all men who are American citizens and who are interested in promoting the cause of industrial preparedness, particularly in connection with the design, procurement, production, manufacture, inspection, test or supply of ordnance material.

"Life membership shall continue during the lifetime of the life member and shall expire at death. It shall not be transferable.

"SEC. 3. Student membership in the Association shall be open to all men who are American citizens and who are students in technical schools or colleges. Student members shall not vote or hold office in the Association.

"SEC. 4. Group membership in the Association shall be open to all individuals, firms, companies and groups controlled by American citizens who are interested in promoting the cause of industrial preparedness, particularly in connection with the design, procurement, production, manufacture, inspection, test or supply of ordnance material.

"Group members shall have the privilege of nominating ten men for full membership in the Association, and members thus nominated shall pay no dues.

"SEC. 5. Honorary membership for life shall be conferred, in the discretion of the Board of Trustees, upon persons who have rendered meritorious service to the cause of industrial preparedness. Honorary members shall be entitled to all privileges of full membership except as otherwise provided in this Constitution and in the By-laws."

By-Laws

"5. The fee for life membership in the Association shall be One Hundred ($100.00) Dollars. The annual dues for membership in the Association shall be, for members, Five ($5.00) Dollars; for student members, Two Dollars and Twenty-five Cents ($2.25); and for group members, One Hundred ($100.00) Dollars, payable in advance. These sums are in addition to whatever dues or assessments may be imposed by the respective local posts in the case of members."

Deceased Member

SINCE publication of the last issue of ARMY ORDNANCE, National Headquarters has learned with regret of the death of Guy H. Morgan, Tenafly, N. J.

New Members

THE following have been admitted to membership in the Association since the last issue of ARMY ORDNANCE: Sherroll L. Bettis, Berkeley, Calif.; John J. Boitano, Arrochar, S. I., N. Y.; W. R. Bowman, Oakland, Calif.; Coleman Campbell, San Francisco, Calif.; W. C. Chancellor, Lorain, Ohio; Francis Lai Chinn, San Francisco, Calif.; George G. Crawford, Pittsburgh, Pa.; H. Gould Dennison, Ventura, Calif.; Philip N. Fletcher, Campbell, Calif.; Elwood J. Fratis, Berkeley, Calif.; Rolfe C. Gosreau, York, Pa.; John B. Goss, Waterbury, Conn.; Charles F. Grebe, Jr., Milwaukee, Wis.; Raymond B. Harris, Detroit, Mich.; Bert H. Hirsch, San Francisco, Calif.; G. E. Hitchens, McKeesport, Pa.; Samuel L. Kerr, Philadelphia, Pa.; Tracy C. Kerr, Springfield, Mass.; H. B. Kilroe, Milwaukee, Wis.; Earl L. Kullmann, Milwaukee, Wis.; Theodore W. Legatski, Bartlesville, Okla.; Joseph N. Mahoney, Brooklyn, N. Y.; Wm. J. McLeod, Oakland, Calif.; E. M. Miller, Woodlawn, Pa.; Joseph G. Morris, E. Alton, Ill.; Hamnett P. Munger, Middletown, Ohio; Hayward Niedringhaus, Granite City, Ill.; Lee Nutting, Berkeley, Calif.; Lamar S. Peregoy, Milwaukee, Wis.; George L. Pollock, Chicago, Ill.; John B. Preston, Stanford University, Calif.; Wingate Reed, New York, N. Y.; H. M. Reedall, San Francisco, Calif.; P. P. Reese, Lorain, Ohio; John R. Reilly, Winetka, Ill.; G. A. Reuff, McKeesport, Pa.; J. H. Reynolds, Gary, Ind.; Albert L. Robinson, Berkeley, Calif.; Melvin B. Rowan, Bishop, Calif.; F. D. Sanborn, Jr., E. Cleveland, Ohio; Walter C. Sanders, Canton, Ohio; B. R. Sherwood, Brooklyn, N. Y.; M. J. Swatek, Jr., Chicago, Ill.; John H. von Husen, San Francisco, Calif.; A. Roland Wood, Rio Vista, Calif.; Arthur P. Woodman, Evanston, Ill.

Professional Notes

Colonel Dickson Describes Metallurgical Advancements of Ordnance

COL. T. C. DICKSON, Commanding Officer of the Watertown Arsenal, Watertown, Mass., in an address to the members of the Cleveland Engineering Society, May 13, recounted the revolutionary progress that has been made recently in the production of guns. The meeting, at which about 800 members and guests were present, was held in the ballroom of the Hotel Winton. The speaker was introduced by Col. Frank Scott, a director of the Army Ordnance Association, chairman of the board, Warner & Swasey Co.

Colonel Dickson's discussion of how guns are now made of centrifugally cast alloy steel, are cold-worked so as to increase their physical properties and are mounted on carriages and other apparatus built up of successfully welded members, instead of steel castings, was a most interesting one. It was told entirely by running comment on lantern slides. The following account is abstracted from *The Iron Age*, May 22, 1930.

Colonel Dickson prefaced his address with a recital of his familiar work on the cold-working of forged guns by hydraulic pressure. Instead of making a built-up muzzle of separate forgings shrunk on each other, the Watertown Arsenal succeeded some time ago in taking a solid piece of steel, machining it to the proper size, and then by cold work bringing it to its final shape. The one piece has properties superior to the assembly of separate forgings.

In cold-working, the one-piece muzzle or gun is subjected to a hydraulic pressure up to 120,000 lbs. per sq. in., so that the interior bore or diameter is increased 6 per cent, but the outside diameter only a small amount, about 0.80-in. This process, carried out in specially built apparatus, increases the elastic limit of the steel. By suitable heat treatment after this hydraulic cold working, the elastic limit is still further increased.

At present, some of the smaller guns are being cast centrifugally in a special machine to a suitable shape, approaching that of the final gun. The steel is melted in an Ajax-Northrup high-frequency furnace and poured into the rapidly revolving mold, at regulated speeds and temperatures, directly from the furnace itself, which is transported to the mold. The grade of steel used is a molybdenum alloy steel, containing 0.35 to 0.40 per cent carbon and about 0.40 per cent molybdenum. Occasionally a small percentage of vanadium is used. Removed from the machine at a heat above its recalescence point, the piece is properly heat treated.

A feature of the centrifugally cast piece, emphasized by Colonel Dickson, is the fact that the carbon content of the inner bore is higher than the outside of the piece. It was also emphasized that the schims and other impurities collect on the inside of the hollow casting and are easily removed. Attention was called to the superior structure of the metal. Defects which unavoidably collect in small measure on the outside are easily machined off.

The next step is to give it the hydraulic cold-working treatment. The casting is placed in a special container which, briefly, is a metal jacket, the dimensions of which are those desired in the finished gun. At this point the gun is subjected to the same hydraulic expansion used formerly on forged guns, with the same or better physical preperties resulting.

Advantages of these new developments are many. In particular it is possible to make more guns in less time by this process and at less cost—an important consideration in time of war. One casting machine can produce at least three guns while one is being made by the forging method. The excessive machining and boring necessary on forgings is largely eliminated and the physical properties of the product are superior. There is also less likelihood of defects in a product thus made than from the older process and the superiority over the built-up gun is evident. Several types and sizes of guns have been made by this process.

Colonel Dickson demonstrated that, by the use of proper welding apparatus and rods, gun carriages of several types are being produced by built-up structural members joined by welding, so that the cumbersome and heavy cast steel carriages are eliminated. He presented on the screen many examples and described the advantages.

The role of the x-ray in this work also was carefully explained. Perfection of the welding process and reliability of the welded products are possible only by careful checking by x-ray examination.

The art has been so perfected that the Army can now be supplied with light apparatus that is not only reliable in supporting guns in action, but is easily transportable over wide territory. He explained how, by suitable structures, guns are being transported on commercial trucks to almost any desired location. A welded tractor equipment has been developed which, applied to the six wheels of a truck, enables it to easily negotiate the most difficult terrain. The caterpillar equipment is so simple and yet so light that it can be removed or put on any large commercial truck. With the new welded supports or carriages, guns of various sizes and types are ready for immediate action in almost any locality. The contrast between this and the older artillery equipment was vividly pictured.

Several questions were answered by the speaker. Asked why molybdenum steel is used, the answer was that it is the best alloy steel possible for the severe requirements that have to be met. The speaker pointed to the excellent physical properties, particularly the elongation and reduction of area, as revealed by tests put on the screen, including the tensile properties.

As to whether any special welding process was used, the lecturer replied that regular commercial equipment is pur-

chased, but the work must be regulated by the x-ray and the welders carefully trained.

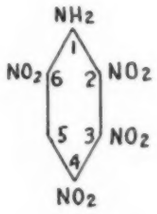
It was explained in reply to another question that the largest gun made by the centrifugal process weighed about 8,000-lbs. The capacity of high-frequency electric equipment is not yet large enough to meet this demand, large melting furnaces of this type are on order, up to 5,000 lbs. and over, which will simplify such melting problems.

Colonel Dickson stated that the one-piece, centrifugally cast alloy steel gun, hydraulically cold-worked, has come to stay and predicted large things for it "in the next war."

The Instability of Tetranitroaniline

TETRANITROANILINE, commonly designated in the explosives industry as TNA, was first developed as an explosive by Dr. B. J. Flurscheim, who patented it in the United States in 1912. Owing to the high rate with which the compound detonates and its high brisance it attracted attention for some time as a possible charge for boosters, and was investigated in this connection by the Ordnance Department prior to and during the World War.

Question was soon raised regarding the stability of TNA, this being based partly on theoretical considerations and partly on the results of special tests. The compound tetranitroaniline contains four nitro groups in the benzene ring, the structural formula being represented as follows:



When the benzene ring contains 3 nitro groups in adjacent position as the 2, 3, 4 positions indicated in the formula, the intermediate group, as in the 3 position is said to be labile, i. e., it is not as firmly held in the compound as the other nitro groups and is hence more readily removed by reaction with other compounds or by elevated temperatures. From this point of view it was expected that TNA might not be as stable as TNT or picric acid which do not have a labile nitro group. This view was supported by the fact that when the TNA was subjected to the K. I. heat test at 65.5° C. it showed evidence of decomposition very readily when only small amounts of moisture were present. It appeared that at only moderately elevated temperature the labile nitro group was separated from the compound by reaction with moisture, i. e., hydrolysis occurred, thus indicating instability.

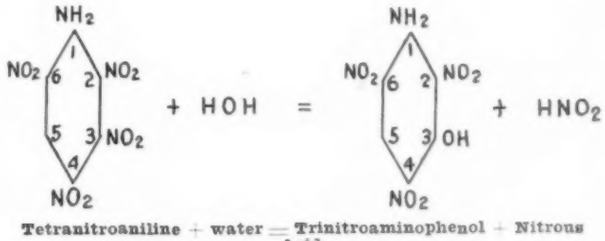
It was considered that this reaction of TNA with moisture would not detract from its value as a military explosive, since the TNA would be dry when loaded and was regarded as nonhygroscopic. It was therefore approved as a substitute for tetryl and a plant for its manufacture was built, but owing to the early termination of the war only a small amount was actually produced.

In connection with a general study of the stability of high explosives conducted at the Picatinny Arsenal since the war, additional information of interest has been obtained on TNA. A box containing 50 one-pound cartons of TNA was set aside in magazine storage in 1920. One carton was removed each year and the explosive tested for stability and other explosive properties. A brief summary of the essential data follows:

Year	Acidity as H_2SO_4 (percent)	Melting Point	Moisture (percent)	65.5°C. K. I. Stability Test	Heating at 135°C.	Sand Sensitiveness. Wt. of Fulminate	Test Brisance Wt. of Sand Through 30 Mesh
				Minute			
1921	0.02	210.0°C.	0.25	30	.....	0.18 gms.	.....
1923	.05	208.4	.21	30	No. explosion in 5+hrs.	0.18 "	42.3 gms.
1928	.59	204.1	.35	6	"	0.24 "	40.9 "
1929	1.12	204.4	.45	1	Explosion in 15 Min.	0.24 "	38.1 "

On referring to the tabulation, definite indications of decomposition will be noted in the variations among the periodic results. For example: a drop of 5.9° C. from the initial melting point, an increase in the moisture content to .45 per cent from the original .25 per cent. The acidity shows a significant increase to 1.12 per cent from the former .02 per cent, expressed as H_2SO_4. A marked development of insensitiveness to detonation is also evidenced in the results of the sand test; in the tests of 1923, and prior to that date, 0.18 grams of mercury fulminate was required to produce detonation, while in tests after 1923 a greater weight was required, i. e., 0.24 grams. The results of the 135° C. heat test up to 1928 indicated that TNA was at least not markedly unstable since it did not explode at this temperature after 5 hours. In 1929, however, explosion occurred during a short period of heating at this temperature. This result with the increase in the acidity, which was practically double that of 1928, showed very definitely that decomposition was in progress at a much greater rate than formerly. Removal from magazine storage and disposal were considered imperative.

A sample of the decomposing explosive, upon further laboratory investigation, showed the presence of about 2.5 per cent of water-soluble material, although the TNA itself is practically insoluble in water. This water soluble compound was isolated and identified as trinitroaminophenol. The presence of this decomposition product is in line with the suggestions given above regarding the reactivity of the labile nitro group, as the trinitroaminophenol would be expected to develop in the following manner:



Tetranitroaniline + water = Trinitroaminophenol + Nitrous Acid.

This tendency of tetranitroaniline to react with water and liberate acid is a definite weakness which would be unfavor-

able to its use as a military explosive, since long periods of storage of such explosives are often necessary.

W. T. INGRAHAM,
Picatinny Arsenal.

Meeting of Ordnance Advisory Committee, S. A. E.

LIEUT. COL. A. F. MASURY, Specialists' Reserve, as Chairman of the Ordnance Advisory Committee of the Society of Automotive Engineers, called the twenty-second meeting of that committee in Peoria, Illinois, May 23 and 24. The first day of the meeting was devoted to inspecting the plant of the Caterpillar Tractor Company, the manufacturers of the standard Army track-laying tractors which are used as prime movers for motorized Field Artillery organizations. The executive session was held May 24th at the Caterpillar Plant.

The advisory committee is composed of members of the Society of Automotive Engineers and includes the foremost automotive engineers of this country in its membership. This committee, since its organization in 1919, has assisted the Ordnance Department of the Army very materially in its military automotive investigations and developments. By means of these meetings held twice a year the members have energetically contributed their time, knowledge and experience to the Army and thus kept the Ordnance Department abreast of all important commercial automotive developments and have enabled it to utilize them most advantageously in perfecting military design and production plans for procurement in case of emergency.

The membership of the committee includes the following engineers: Colonel Masury, Chairman, Vice-President and Chief Engineer, International Motor Company, New York, N. Y.; Col. H. W. Alden, Ord. Res., Chairman of the Board of Directors, Timken Detroit Axle Company, Detroit, Mich.; Col. William G. Wall, Ord. Res., Consulting Engineer, Indianapolis, Indiana; Maj. A. W. Herrington, Q. M. Res., Eastern Representative, Coleman Motors Company, Washington, D. C.; Maj. Emil F. Norelius, Ord. Res., Chief Engineer, Monarch Tractor Corporation, Springfield, Ill.; P. E. Holt, Vice-President and Director, Caterpillar Tractor Company, Stockton, Calif.; G. A. Green, Vice-President in charge of Engineering, General Motors Truck Corporation, Pontiac, Mich.; G. A. Round, Engineer, The Vacuum Oil Company, New York, N. Y.; Floyd C. Hecox, Engineer, Cadillac Motor Car Company, Detroit, Mich.; John F. Winchester, General Superintendent of Motor Equipment, Standard Oil Company of New Jersey, Newark, N. J.; Arthur J. Scaife, Engineer, The White Company, Cleveland, Ohio.

In holding this meeting at Peoria emphasis was given the loss to the committee of Lieut. Col. William Turnbull, Spec. Res., formerly Chief Engineer of the Caterpillar Tractor Company, who died February 9, 1930. He had been an active member of the committee for about four years.

The following personnel of the Ordnance Department conferred with the Advisory Committee at this meeting:

Col. E. D. Bricker, Chief of Technical Staff; Maj. W. P. Boatwright, Chief, Artillery Division, Manufacturing Service; Maj. Robert Sears, Chief, Automotive Testing Division, Aberdeen Proving Ground; Maj. B. O. Lewis, in charge of manufacture, Rock Island Arsenal; Maj. A. W. Ford, Chief, Artillery and Automotive Division, Technical Staff; Capt. John K. Christmas, Automotive Section, Manufacturing Service; H. A. Knox, Automotive Engineer, Automotive Section, Manufacturing Service, and W. F. Beasley, Automotive Engineer, Automotive Section, Technical Staff.

The committee examined and approved tank and armored car studies prepared by the automotive branches of the Ordnance Department and contributed its customary valuable advice on matters of this nature. The members of the Committee and attending officers were guests of the Caterpillar Tractor Company at a dinner at the Peoria Country Club at which Mr. M. M. Baker, Director, was toastmaster. On behalf of the Ordnance Department Colonel Bricker was the speaker of the occasion.

More Automatic Arms and Cannon for Infantry

THE War Department has approved a provisional reorganization of the war-strength infantry division, which contemplates increased use of automatic arms and cannon. This reorganization will be used as a basis for further test of the reorganization of the infantry division as a whole. Other arms and services represented in the infantry division will study the reorganization with a view to proposing a new provisional organization of their own to conform to that of the infantry.

The immediate reorganization of the 29th Infantry, Fort Benning, Georgia, in accordance with the new scheme and within the limit of its present personnel is included in the approval.

Study and test of the reorganization of the infantry of the war strength division to obtain increased fire power with the infantry weapons now standard and available have been in progress at the Infantry School, Fort Benning, Georgia, since July, 1929. The recommendations recently submitted by the Chief of Infantry, based on these studies and the plan approved by the War Department, contemplate the following important changes:

Increasing automatic rifles in the squad from one to two, with a corresponding reduction in magazine rifles.

Increasing the number of machine guns in the battalion from twelve to sixteen.

Adding a machine-gun company of sixteen guns to the infantry regiment.

Increasing the number of 75-mm. mortars and 37-mm. guns in the infantry regiment from three each to eight each.

The reorganization of the infantry of the division under the new plan contemplates one tank company of twenty-four tanks, a division headquarters company, a military police company, and two infantry brigades composed of a headquarters and headquarters company and two infantry regiments each. The regiment comprises a headquarters and headquarters company, a service company, a cannon company of eight 37-mm. guns and eight 75-mm. mortars, a caliber .30 machine-gun company of sixteen guns, and three combat battalions. The battalion includes a headquarters and headquarters company, three rifle companies, each armed with 144 rifles and thirty-six automatic rifles, and one machine-gun company of sixteen guns.

The newly-approved war strength infantry brigade with 128 machine guns shows a decided increase in these powerful weapons over the World War brigade which had ninety-six machine guns, and over the present war strength brigade with seventy-two machine guns. Likewise, the number of automatic rifles in the new brigade—648—is

about double that of the World War organization of 384 and the present brigade of 324. This increase speaks for greatly increased fire power. The increase in infantry cannon, which is designed to provide a counter for the modern tendency to fight with armored vehicles, is likewise marked. The new war-strength regiment provides for eight 37-mm. guns and eight 75-mm. mortars of increased range and accuracy, as compared to the World War regiment of three 37-mm. guns and six mortars and the present regimental organization of three each of these weapons.

The tendency to increased use of motor transportation evident in modern armies is reflected in this reorganization by motorizing all field trains of the infantry regiment, such trains now being animal-drawn. The combat trains remain animal-drawn.

Mechanization Includes the Band!

A MECHANICAL substitute for an Army band, manufactured by the Radio Corporation of America, will be procured by the Army for service test. This device will be issued to Fort Washington, Maryland, for test by the 3rd Battalion of the 12th Infantry.

It is contemplated, if this apparatus is finally adopted for use by the Army, to utilize it at stations which have no bands. There are at the present time sixteen such establishments garrisoned by line troops. In addition to these there are no bands at some service schools, some flying fields and recruit depots. At all of these such a mechanism would provide the necessary music for ceremonies, marching, disciplinary drills and recreation purposes.

The apparatus is a neat unit, ruggedly built into a ¾-ton truck. The volume of music developed is equivalent to two large bands and may be diminished or increased as desired. The quality of the music is approximately as good as that of the average service band. It is capable of playing while in motion to the same degree as is a dismounted band. Its mobility while not playing is about that of the standard ¾-ton truck.

This apparatus can be used as a complete substitute for the instrumental music of the band and to a limited degree for field music. It is impossible to utilize it in conjunction with a band, therefore, there will be no reduction in the strength of bands.

Antiaircraft Exercises at Aberdeen

THE Secretary of War has approved a program for the fifth annual antiaircraft exercises to be held at the Aberdeen Proving Ground. The exercises will start August 15th, and will be conducted under the joint supervision of the Chiefs of Ordnance, Coast Artillery and Air Corps. The latest types of fire-control equipment including directors, height finders and transmission systems will be tested in connection with the recently standardized mobile 3-inch gun and mount, the fixed 105-mm. gun and mount, and the most recent type of 37-mm. gun and mount. Multiple machine gun truck mounts equipped with caliber .50 machine guns will also be tested exhaustively to determine their value in the protection of marching columns from enemy aircraft.

These annual exercises have been of the greatest value to the Ordnance Department and the Coast Artillery in perfecting matériel for combating hostile aircraft. The present state of development of our antiaircraft equipment is attributed largely to information obtained during extensive tests conducted in connection with the annual antiaircraft exercises. The matériel is tested by actual firings at sleeve targets towed by airplanes at altitudes varying from 5,000 to 18,000 feet. The Air Corps has developed a high degree of skill in towing targets, and the firings represent the nearest approach to actual war conditions possible in time of peace.

Evolution of Caliber .30 Armament, 1917-1930

THE utility of automatic and semiautomatic fire arms, and their rapid increase in numbers compared with the hand-operated magazine rifles can be fully comprehended from a statistical study recently made in the Office of the Chief of Infantry which shows that the proportion of automatic and semiautomatic weapons as compared to rifles in the infantry regiment has increased from 1 to 303.3 in May, 1917, to 1 to 4.5 in June of this year. The latter figure is in accordance with a provisional organization recently approved.

The evolution of the armament of Infantry in caliber .30 weapons is clearly shown in the following review: In May, 1917, the infantry regiment had six machine guns and 1,820 rifles, a proportion of 1 of the former to 303.3 of the latter. There were no automatic rifles in this organization.

During the World War there were 48 machine guns (including proportion of infantry brigade guns), 192 automatic rifles and 3,200 rifles, a proportion of 1 automatic cal. .30 weapon to 13.3 magazine rifles. The proportion of machine guns to rifles was 1 to 66.6. The proportion of automatic rifles to rifles was 1 to 16.6. In our present regiment there are 36 machine guns, 162 automatic rifles and 1,852 rifles, a proportion of 1 automatic weapon to 9.4 rifles. The proportion of machine guns to rifles is 1 to 51.4. The proportion of automatic rifles to rifles, 1 to 11.5.

In the provisional organization recently approved there are to be 64 machine guns, 324 automatic rifles and 1,751 rifles, a proportion of 1 automatic weapon to 4.5 rifles. The proportion of machine guns to rifles is to be 1 to 27.3. The proportion of automatic rifles to rifles is to be 1 to 5.4.

Contracts Awarded for Airplanes, Engines and Accessories

CONTRACTS for new airplanes, engines and accessories, amounting to $5,963,419.38 were approved recently by the Secretary of War. The purchase of this equipment for the Army Air Corps will be paid for out of the funds made available by the 1931 Army Appropriation Bill, which was approved by the President on May 28th. The expenditure will result in the Air Corps receiving 402 new airplanes, with spare parts, and 128 new engines and spare parts.

The Douglas Company, of Santa Monica, Calif., was awarded a contract for $2,221,623.60, covering 146 Model BT-2B basic training airplanes with spare parts, and 44 Model O-38 observation airplanes with spare parts.

A contract totalling $1,543,183.90, awarded the Boeing Airplane Company, of Seattle, Wash., a subsidiary of the United Aircraft Company, covers 131 Model P-12C pursuit planes with spare parts.

Under its contract with the Air Corps, the Thomas-Morse Aircraft Corporation, of Buffalo, N. Y., is to construct 71 Model O-19C observation planes, with spare parts, at a total cost of $1,018,126.20.

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Reviews

ARMY ORDNANCE begins in this issue a review of current foreign military periodicals. Only those articles selected from the many publications received regularly in the editorial offices which relate to the technical and broader phases of munitions development are reviewed.

The Review Department, which will appear in each issue, is under the direction of Mr. J. Marron Dundas, a member of the Editorial Staff of this Journal.

CANADA

Canadian Defence Quarterly
January, 1930

THE EVOLUTION OF ARMORED FIGHTING VEHICLES.

The author candidly admits that when he used the word "evolution" here he intended to, or might have put, "the progress of design," which, as his review of various types goes only five years back at most, is a more fitting title. His subject really is, as the contents of the paper show, "The Progress of Design of Armored Fighting and Other Military Mechanized Vehicles." Whatever the title, this lecture by Maj. Gen. S. C. Peck gives valuable data on various models of armored fighting vehicles and carriers, tractors, or dragons, as well as unarmored carriers and transport vehicles. One indulges the hope that the general, at some future time, may lecture on such progenitors of armored design as the *testudo*, beneath which Roman troops advanced to the walls of a besieged town, the "war machine with scythes and armored car" invented by Leonardo da Vinci, and other ancient models. *Prosit.*

IS WAR INEVITABLE?

The answer to this question entails a paper by Maj. K. Stuart, in which he handles well a mighty theme. War has created a vast literature of its own. It has its poets, its own philosophers. Armies created to wage it are, perhaps, among the chief blessings of peace, as they often do more and get less credit for it than any other aggregation of humans. Major Peck here investigates the origin and causes of war, makes a summary of observations evolved and deduced from past events and examines the pacts, covenants and treaties entered into after the World War. He concludes that, after all, a resort to armed force is still a distinct possibility of the future.

THE CANADIAN MILITIA. THE NORTHWEST REBELLION, 1885.

The above title heads an article which is said by the author, or editor, to be an expansion of the chapter entitled "Defence 1812-1912," for which one may consult Vol. VII of "Canada and its Provinces," by the present writer, Col. C. F. Hamilton. The part played by the artillery arm is considerable.

LE FRANCAIS DANS L'ARMEE CANADIENNE. (French in the Canadian Army)

Canada has a wide domain in which dwell inhabitants who speak, perhaps, the French of the days of Jacques Cartier and Montealm. While French, it is colloquially different in some respects from the idiom known by those

of us educated among Parisians. Its literature, however, compares well with that of the mother country, and Maj. Ernest Legaré, speaking for the military use, deprecates the use of anglicized French terms instead of the true Gallic words or phrases ready to hand.

FRANCE

Revue D'Artillerie

February, 1930

STUDY OF A CONCRETE CASE OF THE USE OF ARTILLERY IN ATTACK. (Continued.)

ARTILLERY IN THE OFFENSIVE IN A WAR OF POSITION. (To be continued.)

A MECHANICAL FIRE TABLE UNDER THE FORM OF A SLIDING RULE.

ENDURANCE TESTS FOR GASOLINE POWERED TRUCKS AND AGRICULTURAL TRACTORS.

Results are given here in tabular form.

Revue D'Artillerie

March, 1930

STUDY OF A CONCRETE CASE OF THE USE OF ARTILLERY IN ATTACK.

ARTILLERY IN THE OFFENSIVE IN A WAR OF POSITION. (Continued. See p. 129, February, 1930, number.)

A translation from the original German.

THE EVOLUTION OF ARMORED FIGHTING AND OTHER MILITARY MECHANIZED VEHICLES.

This article by Maj. Gen. S. C. Peck, published in the *Canadian Defence Quarterly* of January, 1930, and already noticed in these columns, is here accorded the honors of translation into French.

DAVID RIVAULT DE FLURANCE, BALLISTICIAN.

This eminent scientist published, in 1605, his "Elements of Artillery" which was severely criticized at the time, as may be seen from an extract the author is kind enough to give us. A candid examination of the "Elements of Artillery" has apparently convinced the author of this little brochure that Rivault as a ballistician is worthy of high rank in his science. By turns, soldier, man of letters, traveler, savant, he lived a busy life. He toured Italy and Holland, was a Gentleman of the King's Chamber, went to Hungary with Guy de Coligny, campaigned against the Turks. Wounded at Comorn he returned to Rome and entered the Humanists' Academy. Called to the Council of State by Henry IV, he was successively named under-tutor and tutor to Louis XIII. The technical part of "Elements of Artillery" reads like a modern treatise. A few of its maxims like "Speed is a force which does much in a short time;" "To ascend is to approach Heaven, to descend is to approach the center of the earth," give one an idea of the flavor of this original and racy book on a fascinating subject.

Revue Des Forces Aeriennes

April, 1930

THE 33D AVIATION REGIMENT.

THE FIRST FRUITS OF NIGHT PURSUIT IN FRANCE.

AVIATION IN THE CAVALRY DIVISION.

NOTES ON CAPTIVE OBSERVATION BALLOONS

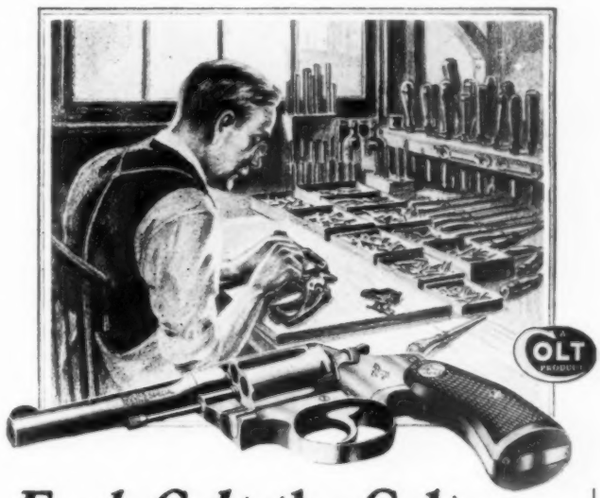
GERMANY

Heerestechnik

April, 1930

THE QUESTION OF INCREASED PERFORMANCE OF INFANTRY ARMS. A GENERAL SUMMARY.

Gives the results of a sort of symposium consisting of



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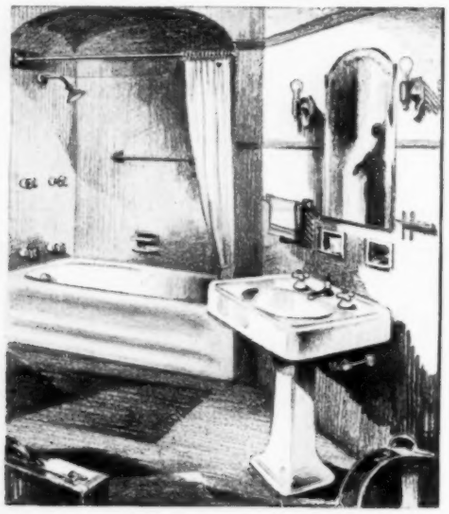

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four articles, or section of one article, entitled "The Influence of the Tactical Development of the Rifle upon Infantry Tactics" to be found in Vol. VII, Nos. 4 to 7 of this journal.

Development of the Six-Wheel, Tri-Axle Cross-Country Truck.

The construction of this truck has been much studied with a veiw to further improvements. The vehicle has been tried out in England and France with reference to military uses, while in Germany its commercial possibilities were the end in view. The models shown were developed by the Fried. Krupp Aetien-Gesellschaft, and the illustrations give the reader a good close-up on the invention.

Zeitschrift Fur Das Gesamte Schiess-und Sprengstoffwesen
April, 1930

A New Apparatus for Determining the Chemical Stability of Smokeless Powders and Nitrocellulose by the Thermostat Method at 75° Centigrade.

The Fouling, Cleaning and Maintenance of Gun Barrels.

A careful description of the phenomena of fouling as caused either by the introduction of foreign bodies such as dust, rust, etc., into the barrel, or by firing and its effects. Methods of cleaning and upkeep are also recounted.

The requirements for such a means are as follows:

Absolute neutralization of elements injurious to the bore, arising from the return current of powder gases forced into the metal wall of the tube after firing.

Complete exclusion of air from the bore surface when at maximum tension.

A high state of polish to facilitate inspection of the bore surface whenever desirable.

Chemical stability in conservation and use of matériel.

Neutral behavior of the means used when in combination with other methods.

The method must be one easy to apply, and

Not injurious to the health of the operator.

Low cost.

Neither vegetable nor mineral oils suit the above requirements as fully as might be expected, says the author, but he believes the sole solution to lie in the use of a specific alkaline soap preparation, for reasons which he gives.

Contributions to the Thermodynamics of Explosive Processes. III. (Continued and concluded.)

GREAT BRITAIN
Journal of the Royal Artillery
April, 1930

The New Artillery.

The point the writer wishes to bring out is, the necessity of so training field artillery officers that they will be able to meet the rapidly shifting conditions now prevailing, for with all the advantages of training as compared with officers of all grades 25 years ago, nothing better or more advanced is found for them to do than they did then. To remedy this defect, captains, for instance, might be assigned "visiting" or liaison duties in addition to a general supervision of their present tasks. They could be given more important missions, or used to reconnoiter for better and alternative O. P.'s and positions. While, however, such duties are talked about at conferences, they never are assigned to them in maneuvers. The same expedients, making allowance for differences in rank, might be adopted in

the case of the remaining officer personnel. In other words, let each officer do something in a practical way over and above his present routine duties.

MEANS OF PROMOTING CLOSER RELATIONS BETWEEN REGULAR ARMY AND TERRITORIAL ARMY UNITS OF THE ROYAL ARTILLERY.

The chief fault here, according to the author, is the lack of fraternization between Regulars and Territorials. Both must meet each other more than half way and be brought together in such a way that a friendlier feeling will obtain between the former and the latter.

MOVING WARFARE. THE ARTILLERY AT ROSSIGNOL, 22ND AUGUST, 1914.

This article is by a French officer, Col. Grasset, D. S. O. He recounts the general situation, gives the march orders and describes the battle, and concludes with an eulogium to the gunners of the 3d French Colonial Division.

THE HONOUR TITLES OF BATTERIES IN THE ROYAL REGIMENT OF ARTILLERY. (Continued from Vol. LVI, p. 487.)

THE BOMBARDMENT OF THE HARTLEPOOLS, DECEMBER 16TH, 1914.

Additional details to those published by Col. L. Robson, C. M. G., D. S. O., the fire commander at the time, in Vol. XLVIII, No. 10, January, 1922.

ITALY

Revista De Artiglieria E Genio

May, 1930

THE EMPLOYMENT OF DIVISIONAL AND CORPS ARTILLERY IN AN OFFENSIVE BATTLE IN MOBILE WARFARE.

MECHANICAL EQUIPMENT OF SAPPER AND MINER UNITS. (Continued and ended.)

The sections of this paper hitherto published constitute what seems to be a satisfactory treatment of the subject, which, as is usual in this journal, is considered under various heads. The present part of the article begins with certain deductions after which successively appear comments on the mechanical industries, shops having mechanical equipment, their uses, and the equipment of this kind which should be owned by Engineer units.

MINIMUM VELOCITY.

A rejoinder to a paper by General Cavalli criticizing in a friendly way, one by the author, Lieut. Gen. Antonio de Stefano (Artillery).

IMPORTANCE OF THE FORMIC AND ACETIC ALDEHYDES IN THE PREPARATION OF EXPLOSIVES.

PORTUGAL

Revista De Artilharia

April, 1930

THE BATTLE OF "LA LYS" AND SIGNAL COMMUNICATIONS. (Continued.)

SOME CONSIDERATIONS UPON COAST DEFENCE. (To be continued.)

Maj. A. J. Aguiar confesses himself to be deeply saddened that so many of his comrades in the service, illustrious for their talents and distinguished for their knowledge of modern improvements in this branch of artillery, have contributed so little to make known the possibilities of the latter in peace time. To enforce his point he quotes an article which appeared in the *Coast Artillery Journal* on "The Activity of Pacifist Societies." His paper is both interesting and instructive.

SMITHWELDING

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Books

The New International Year Book. A Compendium of the World's Progress for the Year 1929. Herbert Tredwell Wade, Editor. New York: Dodd, Mead and Company, Inc. 1930. $6.75.

THIS is the twenty-eighth volume of a series which has merited general favor and long since has become established and appreciated as an annual reference work. The editor, Maj. Herbert Tredwell Wade, Ord. Res., is an active member of the Army Ordnance Association.

In the fields of international relations, political and economic developments, literary and educational progress, the social sciences and technical and engineering advancement the work, as in former years, is an authentic compilation of the past year's addition to history.

The article on Military Progress again is contributed by Col. John J. Bradley, Inf., U. S. A., Ret.; that on Naval Progress and related subjects by Capt. Lewis S. Van Duzer, U. S. N., Ret.

Colonel Bradley includes in his review a resumé of developments in the light of the Kellogg Pact, the League Covenant, the Pacific and Locarno treaties and the optional clause of the Permanent Court of International Justice. Discussion of mechanization in Great Britain is lengthy while aircraft and motorization receive major attention in the narrative of American progress.

The Universe Around Us. By Sir James Jeans, M. A., D. S. C., LL. D., F. R. S. New York. The Macmillan Co. 1930. $4.50.

IS it possible to present in simple language an account of the "methods and results of modern astronomical research, both observational and theoretical"? One of England's great astronomers, Sir James Jeans, who combines an extraordinary ability of simplifying the difficulties and intricacies of modern science with unusual achievements in his own field of investigation provides a positive answer to this query.

In as fascinating a book as can be imagined, he explores space to the furthest heights to which our telescopes can probe. He investigates the structure of the atoms of which the whole universe is built. He describes the evolution of the universe, of the stars, of our own solar system. There is nothing austere in his descriptions. It is the story of an enthusiast that kindles the enthusiasm of the reader.

That we should find it necessary to descend from these sublime considerations to mundane quarrels is unfortunate. Yet we feel it a decided defect that no mention is made of the work of Chamberlin and Moulton of Chicago in the development of their planetesimal hypothesis. This was commenced in 1910 whereas the "tidal theory" of Sir Jeans dates from 1916. Surely in this marvelous work of superseding Laplace's hypothesis there is glory enough for all, and the inclusion of the names of the two American astronomers would not diminish the credit due the author for his part in this epoch-making development.

Reducing Transportation Costs by Means of Engine Design. International Nickel Co., 67 Wall St., New York, N. Y. Pamphlet.

A reprint of a paper presented before the Society of Automotive Engineers by R. J. Hall, Vice-President in charge of engineering, Hall-Scott Motor Car Co., Berkeley, Calif. It deals specifically with motor bus engines, and emphasizes the important part which alloy steels and other high-grade materials play in proper design.

Alloy Steels in the Railroad Field. By Charles McKnight, in charge of Alloy Steel Development, The International Nickel Company. (Reprint of paper delivered before the Railroad Division of the A. S. M. E., at the Annual Meeting, New York, December 1929. 12 pages.) The International Nickel Company, Inc., 67 Wall Street, New York, N. Y.

A discussion of the increase in strength with decrease of weight attainable by the use of alloy steel for railroad forgings, castings and boiler plate; for the comparative physical properties of alloy and carbon steels in such applications, and when it is advisable to use each from a standpoint of economical operation. Corrosion-resisting material, nitriding and miscellaneous developments are also treated briefly.

Thomas Jefferson, the Apostle of Americanism. By Gilbert Chinard. Boston. Little, Brown and Company. 1929. $5.00.

IN a biography notable for its impartiality, Professor Chinard has made a distinguished contribution to the history of the events leading up to the American Revolution and of the early days of the Republic. This comprehensive examination of the thought and activities of Thomas Jefferson provides a better understanding of the epoch. The author, of French birth, in a vigorous and impeccable English, analyzes dispassionately the political activities of Jefferson's long career, both in domestic as well as in international affairs.

Without bias in his discussion of domestic matters, the author is eminently fair in all that concerns Jefferson's relations with France. He admits Jefferson's originality in reaching his political conclusions independent of the influence of French thought. He has supported his contentions with innumerable extracts from Jefferson's letters. Professor Chinard's biography, in short, is a thorough and readable study of Jefferson, the statesman and foreign minister.

The Lake of the Sky: Lake Tahoe. By George Wharton James and Edith E. Farnsworth. Boston: L. C. Page & Co. 1929. $5.00.

THIS is one of the seventeen volumes of the excellent "See America First" Series. First published in 1914, this book has been recently revised. As a guide and travel book it is rather unique in that it is so written that it makes fine general reading. At the same time its essential value as a reference book has been maintained by a logical division into over thirty chapters, on such varied subjects as the Indians of that region, its glacial history, camping trips, fishing in Lake Tahoe, the flowers of the district and many other topics, which combine to give a complete picture of one of our country's great natural play grounds. The book has the effect of making an Eastern reader want to travel West rather than to Europe for his vacation.

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